SUPPORTING COMMUNITY GARDENING IN ALASKA THROUGH DEVELOPMENT OF A COMMUNITY GARDEN PRACTICE GUIDE

By

Ryan McWilliams

RECOMMENDED:

____
Nancy Nix, MD, MPH&TM, MEd, CHES
Committee Member

____
Pamela Miller, MS
Committee Member

____
Elizabeth Hodges Snyder, PhD, MPH
Advisory Committee Chair

____
Virginia Miller DrPH, MS, MPH
Chair, Department of Health Sciences

APPROVED:

____
William Hogan, MSW
Dean, College of Health

____
Date

SUPPORTING COMMUNITY GARDENING IN ALASKA THROUGH DEVELOPMENT OF A COMMUNITY GARDEN PRACTICE GUIDE

A

PROJECT

Presented to the Faculty

of the University of Alaska Anchorage

in Partial Fulfillment of the Requirement

for the Degree of

MASTER OF PUBLIC HEALTH

By

Ryan McWilliams, BS

Anchorage, Alaska

August 2016

Abstract

Anchorage is home to an increasing number of community gardens. The body of literature on the health benefits and potential health risks related to gardening in an urban setting has been steadily expanding as the popularity of urban gardening flourishes in cities across the nation. With Alaska Community Action on Toxics' (ACAT) interest in community health, the precautionary principle, and healthy gardening practices, a partnership was developed with ACAT for a project and practicum designed to support these values through environmental testing and analysis, key informant interviews, and a practicum experience culminating in the creation of a guide for Alaska gardeners. The final product of the project was a user-friendly guide entitled *Understanding Urban Soils: A Guide for Better Understanding the Need and Practice of Testing for Garden Soil Contaminants*, in which safe gardening practices and interpretation of soil test results are addressed.

Table of Contents

Page

Signature Page....................i

Title Page....................ii

Abstract.................... iii

Table of Contents iv

List of Figures vi

List of Tables.................... vii

List of Appendices viii

Chapter 1: Background....................1

1.1 Purpose of the Study.................... 4

1.2 Literature Review 5

1.3 Improving the Urban Gardening Network in Anchorage 10

1.4 Urban Gardening and Urban Soil Contamination....................11

1.5 Lead 12

1.6 Emissions 13

1.7 Significance of the Project 15

1.8 Community Partner: Alaska Community Action on Toxics (ACAT) 18

Chapter 2: Research Methods 19

2.1 Goal, Aims, and Objectives....................19

2.2 Soil and Plant Tissue Sampling....................19

2.3 Soil and Plant Tissue Analysis....................22

2.4 Community Garden Study Participant Sampling....................26

2.5 Institutional Review Board (IRB) 28

2.6 Interview Process 29

2.7 Qualitative Analysis of Key Informant Interviews....................29

2.8 Qualitative Limitations 30

2.9 Guide Development Methods 31

Chapter 3: Research Results 33

3.1 Laboratory Analysis 33

3.2 Limitations 36

3.3 Interview Analysis 37

3.3.1 Improving governance. 39

3.3.2 Community action. 42

3.4 Understanding Urban Soils Guide 45

Chapter 4: Discussion and Recommendations 47

4.1 Urban and Community Gardening in Anchorage 47

4.2 Urban Garden Soil Contamination in Anchorage 48

4.3 Understanding Urban Soils Guide Discussion 52

4.4 Alaska's Place in the Global Food System 54

Chapter 5: Project Outcomes, Strengths, and Weaknesses 57

References 59

Appendices 64

List of Figures

Page

Figure 1. The Global Environmental Change and Food Systems (GECAFS) food system concept……………..……………………………………..………..…………………………7

Figure 2. Aerial view of the "C" Street Gardens……...21

Figure 3. Soil and plant tissue sampling grid (soil collected from all sites; plant tissue also collected from yellow sites)………………………………………………………….22

Figure 4. Location of samples ultimately selected for analysis……………………………...25

List of Tables

Page

Table 1. Dry Weight Plant Tissue Samples (samples in yellow were analyzed)……………………………………………………………………………...…...24

Table 2. Plant Tissue Type………………………………...……………………............25

Table 3. 200.8 EPA Analytes……...…………………………….……………..…….……27

Table 4. Soil ICPMS Results …………………...34

Table 5 Plant Tissue ICPMS Results ……………………………………..……………...35

Table 6. Coding Distribution……………………………..…………………..…….……..38

Table 7. Soil ICPMS Results/Screening Levels…...………………………...………...……..49

List of Appendices

Page

Appendix A: Community Gardening Interview Consent Form……………………………………64

Appendix B: Key Informant Questions…………………………………………………………………...…65

Appendix C: Understanding Urban Soils (text-only form of the guide)………………….……66

Chapter 1: Background

The environment around us is an important facet of our health and one in which individuals and communities should have great interest. Urban environments and agricultural environments have merged through the growing practice of urban gardening. Urban gardens can be any number of plant gardens grown in non-rural settings, including personal gardens, school gardens, charity gardens, or community gardens. Community gardens serve groups of people within a community and are generally available to anyone in the community as long as space is available (McKelvey, 2009). Urban agriculture in the form of urban and community gardens has become so popular that cities across the nation are seeing the number of community gardens double, and still many people find themselves on waiting lists for available plots in the gardens (Broyles, 2012; Retis, 2010). Community gardens are a form of urban gardening that is currently flourishing in Alaska as well. Fairbanks, Bethel, Juneau and Anchorage all have relatively large multi-user community gardens and many other Alaskan communities also share less extensive gardens (Smeenk, 2009).

Community gardens can help strengthen communities in a number of ways and can be tailored for most everyone. Youth gardens, gardens for elders, market gardens, charity gardens, therapeutic gardens, crop-demonstration gardens, and rental plot gardens are all forms of community gardens that provide benefits for the community (Smeenk, 2009). Research into the public health implications of community gardens suggests that gardens play a positive role in a number of healthy behaviors and outcomes, such as improved nutritional behaviors, improvements in physical activity and exercise, improved psychological and community well-being, and the promotion of environmental stewardship (Brown, 2000). Community gardens can be beneficial to the surrounding community in several aspects. Community gardens can be used as educational tools, providing learning opportunities in science and math in addition to helping develop organizational, management, and entrepreneurial skills in youth (Smeenk, 2009). Community gardens can also provide financial benefits to the community. In Alaska especially, community gardens can help lessen the burden of paying for expensive imported produce. Localizing produce in Alaska also provides the added health benefit of fresher produce, as compared to imported produce that must travel great distances after harvest.

Another way in which community gardens can provide financial benefit to the community is through the promotion of famer's markets. Community gardens can be run as market gardens selling produce only to cover garden costs and pay workers. Distributing produce grown on a local level in community gardens functioning in this capacity can cut the cost on produce that is brought in through expensive shipping methods, and often community garden produce can be distributed at a minimal and sometimes even free cost, that can offset the high food cost of rural locations while also supplementing local subsistence diets (Smeenk, 2009). Nick Moe, who was the Sustainable Communities Coordinator at Alaska Center for the Environment (ACE), echoes the benefits of producing local food by highlighting the benefit of economic stimulation through the purchase of local produce by local restaurants (Moe, 2013). While unable to function at the high production capacities of farms, urban and community gardens could play a role in the Alaska Grown Program. In addition to the previously mentioned benefits, the American Community Gardening Association (ACGA) also recognizes that community acts as a catalyst for community and neighborhood developments that can have even further positive extensions into the improvement of peoples' quality of life (ACGA, 2013). It still remains key to supporting urban and community gardening that the immediately recognizable benefits of better nutrition, increased physical activity, and cost benefits are highlighted and promoted.

Food insecurity is a persistent problem in Alaska, and urban and community gardens are one great way to grow agriculture and food security within the state. From 2004-2006, Alaska ranked 15th in the nation in overall food insecurity as defined by the World Health Organization (WHO), whose goal is that: “all people in a given population have at all times sufficient, safe, and nutritious food to maintain healthy lives” (Utermohle, 2008; WHO, 2012). It is an unfortunate circumstance that this is not always the case for all Alaskans. Food insecurity is an economical problem at its root. Consequently, other necessary commodities like shelter, energy, and clothing among others have an impact on food purchases (Utermohle, 2008). Because of these factors, lowering the cost of food and increasing availability should be a major focus for the state of Alaska.

Commercial foods provide a measure of food security, but in Alaska availability and quality of these food items is especially subject to changes and vulnerabilities; procurement is dependent on ability to pay; and grocery store produce is often unable to meet culturally specific desires (Loring, 2009). Many drivers contribute to food insecurity in Alaska and for many communities achievement of food security is dependent on locally available food resources (Loring, 2009). Urban gardens, where the majority of Alaska’s population resides, can help alleviate food insecurity by making food proximal and affordable. Many people in cities across the nation have seized an opportunity to increase the amount and proximity of locally grown produce, thus causing rapid growth in the amount of locally grown affordable produce (Broyles, 2012). Community gardens can also provide fresh produce to shelters and food banks, therefore alleviating hunger for one of the major groups suffering from food insecurity in the state (Utermole, 2008). Accessible and affordable food can become more common with more produce grown within the State of Alaska.

It is uncertain and unlikely; however, that urban gardening alone can make a significant impact in Alaska’s food insecurity issues. Yet, urban gardening can and does provide relief for specific populations in Alaska. Considering all other positive health outcomes that urban gardening promotes, it seems a just and worthwhile effort to support and help the practice of urban gardening progress in the state. Urban agriculture is growing through many forms such as community gardening, family urban gardening, and school gardening programs. On the surface, urban agriculture may seem a simple pursuit with simple public health implications; however, with concerns over environmental conditions, social justice, food security, and sustainability, urban agriculture in its many forms takes on an extensive network of public health considerations, from policies to programs (Newman, 2008).

1.1 Purpose of the Study

Understanding the benefits of urban gardening and the needs and issues facing urban and community gardens in Alaska and Anchorage can inform best practices and increase the likelihood of positive health outcomes. Alaska, like most places, stands much to gain from community gardens. The purpose of this project was to conduct a preliminary study of Anchorage's community gardens and create a document that would aid future community gardening efforts in Alaska's largest city. In addition to this effort, the design was also to look into the issue of urban soil contamination, as it was a topic that garnered great interest during MPH coursework. As a way to gain practical experience, soil and plant sampling and analysis were built into the study. Soil contamination became a very prominent focus of the project. By the end of the study, after compiling qualitative data on community gardens in Anchorage from interviews, and collecting and analyzing soil and plant tissue samples, the decision was made to create a guide that would aid gardeners by addressing the issue of urban soil contamination. Urban soil contamination is an issue that is often taken for granted, and although there is information available for urban gardeners in Alaska, many gardeners are not aware of and utilizing those gardening reference sources.

1.2 Literature Review

Food systems have drastically changed in the industrialized areas of the world. The term ‘food system’ is used to describe how food moves from producer to consumer (Fresco, 2009). Food systems include not only the production and harvesting of foods but also post-harvest, processing, marketing and storage (Ericksen et al., 2009; Fresco 2009). A model used to describe food systems in a holistic manner is the “farm to fork” model that encompasses every aspect of the flow of food from the seed being planted, to its movement through the economic system, onward to consumption, and then the disposal or recycling of food waste (Ericksen et al., 2009; Fresco, 2008). In an article for *Chemistry and Industry*, Clair Curran (2001) keys in on the political and social systems’ impacts on the farm to fork model of food systems as she describes the challenges the UK government faces in improving consumer confidence in food while also reviving a fading UK agricultural industry. Literature from Ericksen, Ingram, & Liverman (2009) along with sources from Fresco (2008) and others indicate that the optimization of every component of a food system is the only way total food security can be achieved.

Researching the history of food systems indicates a change from an orientation towards local markets and local consumption to an industrial and globalized system (Fresco, 2009; Verburg, Mertz, Erb, Haberl, & Wu, 2013). This has brought about mass production of food supplies and increased international food trade, but these perceived benefits have come at a cost to sustainability and community health care (Fresco, 2009). This globalized system has become more difficult to manage as climate change affects the world. It has been indicated that there will be a significant reduction in total food production by 2020 in many areas of the world (Verburg et al., 2013). Changes in global population increase the potential risk for food insecurity (Verburg et al., 2013). In Alaska, food security through locally available food sources, especially in “bush” communities have even become vulnerable, as nearly the entire state of Alaska has adapted to industrially produced store bought foods (Loring, 2009). Newman and Ostry (2008), however, remind readers that food security goes beyond the strict framing of food supply and is ultimately a question of long term stability in the environment and food production.

The industrialization and globalization of food production and transportation has noticeably changed the world, and has catalyzed major public health impacts. While not all of the environmental, socio-economic, and nutritional impacts of this globalized system have been fully researched, the overarching determinants of global health have been documented. There has been a loss of biodiversity, a shift of labor, the application of harsh chemicals, and an acceleration of climate change (Newman and Ostry, 2008). The overall effects of the global food system are well-documented and represented in the environmental literature. De-globalizing a food system, should that be a solution, may be harder than creating one in the first place. With the globally integrated economy, socioeconomic changes, and both the urbanization of farmland and the concentration of populations in cities, a return to traditional agricultural practices may not be feasible even if there was a collective will to do so (Kattides, 2008).

The Global Environmental Change and Food Systems (GECAFS) put forth a framework for research based around four food system activities and their perceived outcomes. The four food system activities are: producing, processing & packing food, distribution & retailing food, and consuming food (Ericksen et al., 2009). These four activities are linked to food system outcomes of social welfare, food security, and environmental welfare (Ericksen et al., 2009). Figure 1 represents the relationships between these concepts.

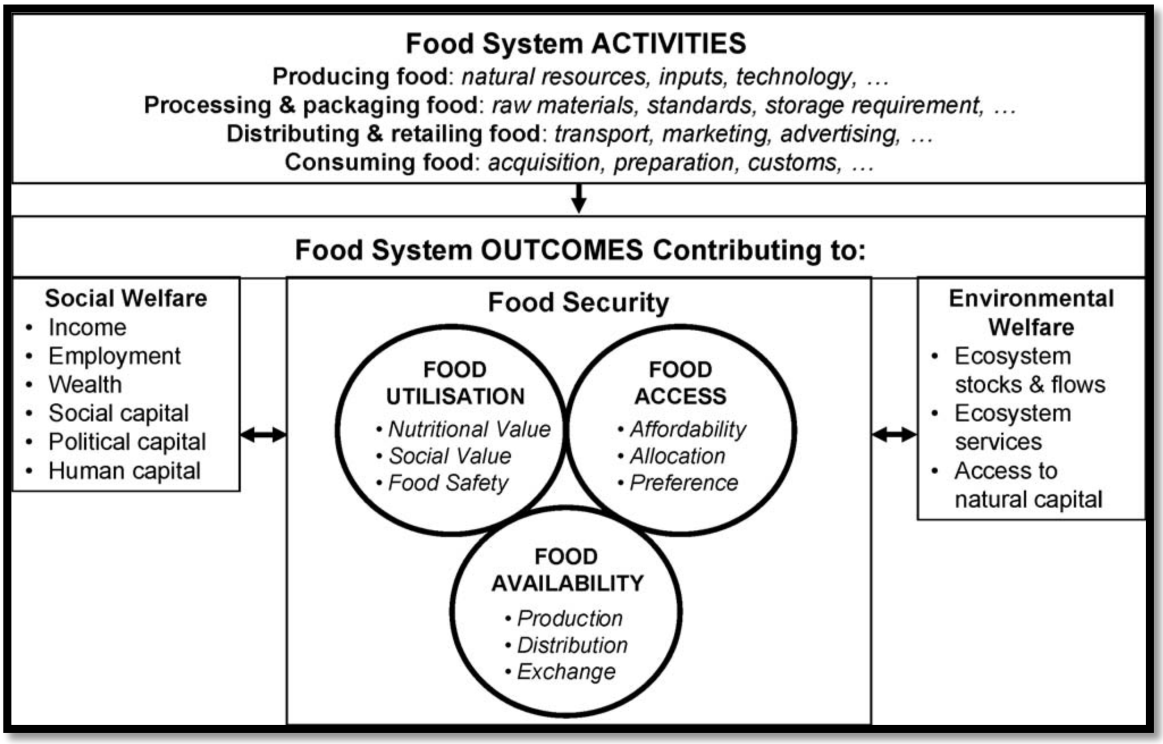

Figure 1. The Global Environmental Change and Food Systems (GECAFS) food system concept (Eriksen et al., 2009)

What the literature indicates through studies done by Fresco (2009), Loring & Gerlach (2009), and Wu, Yeng, Tang, You, Zhou, Chen, & Shibaski (2011) among others, is that global climate change, management of resources, and global population growth put the sustainability of production and the economic impacts of processing and distribution in a precarious position. One can search through the literature and find numerous food system challenges, future food system challenges, future environmental change impacts, socioeconomic challenges and impacts, and research relating to virtually every known public and environmental health aspect. One can weave his or her way through the literature and find himself or herself engrossed in a subject that while directly related to the global food system, is entirely free standing and more narrowly focused at the same time. The food system approach has identified the importance of considering multiple levels and drivers of food security (Ericksen et al., 2009). Although urban agriculture is just one level at which a food system can be studied, it can be examined as a microcosm of the global food system.

The environmental impacts of industrial food systems have contributed to the renewed interest in growing locally produced food (Newman, 2008). The economic impacts of the modern food system have urged people towards urban gardening as a way to lessen the financial burden of commodified foods and to ensure food security (Wakefield, Yeudall, Taron, Reynolds, & Skinner, 2007). Barriers are still prevalent within urban agriculture, however. Poor urban soils, lack of gardening knowledge, lack of usable space, zoning restrictions, and personal time constraints all hinder the expansion of urban gardening (Newman, 2008). Another challenge to the success of urban gardening is its scale. A dominant approach to local food system development is based on "small is beautiful," meaning marginal improvements, the use of simple technologies, and an emphasis on disadvantaged areas are all applauded (Fresco, 2008). What is found in the literature, however, is that these are highly successful from a humanitarian point of view but do little to provide a stable ground for long-term food security (Fresco, 2009).

In Alaska, local food systems also include, for many, traditional subsistence resources such as sea mammals, caribou, moose, fresh and saltwater fish, migratory waterfowl, wild berries, and other botanical sources (Loring, 2009). When rural residents make the common move to urban centers to meet their needs for jobs, cheaper food, cheaper fuel, and affordable health care (and possibly increasingly to escape detrimental effects of climate change), they bring with them a variation in the definition of local food. So, too, do Alaska's growing immigrant populations, whose relocations can often be traced back to detriments to the global food system such as the commodification of food and the exacerbation of climate change (Loring, 2009). This creates the challenge of meeting the diversity of scales and levels within food systems needed to provide sustainability in the holistic approach of "farm to fork" (Ericksen et al., 2009; Fresco, 2009).

Healthy communities require an expanded view of health beyond the individual to account for the complex interactions of health determinants (Hancock, 1985). Urban gardening contributes positively in a number of these determinants such as nutrition, physical activity and exercise, mental health, security and safety in local communities, social capital, environmental stewardship, food security, and social diversity, biocultural diversity, and biocultural preservation (Brown & Jameton, 2000; Kwik, 2008). While the food system literature indicates a need for large-scale interventions and policies to correct many of the sustainability issues inherent in the system, one can find that urban gardening impacts this on a local level with improved local ecology and sustainability, which can lead to long-term improvements in health (Hancock, 2001; Wakefield et al., 2007). Many participants in community gardens studies indicate that these benefits are intuitive and that they are aware of the benefits they are receiving from gardening without previously having been told (Wakefield et al., 2007). Often, gardeners even voice their belief in the gardening connection to improved mental health through interaction with nature (Wakefield et al., 2007). It also appears from Wakefield, Yeudall, Taron, Reynolds, & Skinner's (2007) study of southeast Toronto gardeners that gardeners perceived a benefit to the community as a whole through improved relationships, community pride, and a gateway to broader community improvement. A study conducted by Ohmer, Meadowcroft, Freed, and Lewis (2009) indicated similar results with participants indicating that a community conservation program based around gardening revitalizes their neighborhoods, beliefs in conservation issues, sense of community, and inspiration for volunteerism. Community gardens have been shown to produce an even higher level of these positive effects in disadvantaged and underserved communities (Ohmer et al., 2009; Wakefield et al., 2007).

However, the literature also indicates obstacles for the growth of urban gardening as a health promotion tool. Simply recovering the will to move toward sustainability and recover the values of social interaction, community cohesion, and consumption of locally and produced foods is a present challenge (Kattides, 2008). Urban areas have many projects competing for space, thus making the acquisition of green space for developing community gardens a very difficult challenge (Fresco, 2009). In order to support viable and sustainable food systems, urban agriculture projects will need to create strong partnerships with agencies and organizations that can contribute to gardening initiatives, and these initiatives and programs must be based around linking these programs more strongly to community development strategies (Ohmer et al., 2009).

1.3 Improving the Urban Gardening Network in Anchorage

According to the Trust of Public Land, in 2009 Anchorage was among the top ten cities in the United States with the most gardening space per capita and had at least six community gardens in 2009, a number which has grown since that year [Alaska Daily News (ADN, 2009; Wakeman, 2012]. At the time of this study, a simple internet search net a result of four easily located community gardens. These gardens are the “C” Street Community Gardens, the McPhee Community Gardens (which may be Anchorage’s most utilized garden), the Fairview Lions Park Community Gardens, and the Gardens at Bragaw community garden. These four community gardens provide a total of 154 plots. No data on the amount of residential or faith-based urban gardens are currently available, but any person making use of the multiple trails systems in Anchorage or spending time around their local neighborhoods can discover urban gardens in their neighbors’ yards. It is apparent from the literature that urban gardens (not just community gardens) succeed when there is a community network around them (Wakefield et al., 2007). Having insight into Anchorage’s community gardens and Anchorage’s gardening community may be of major importance to improving the stability and benefits of urban gardening in Anchorage and Alaska.

1.4 Urban Gardening and Urban Soil Contamination

The practice of urban gardening seems like a perfect fit for Anchorage and other Alaskan communities, as the state is known for its outdoor activities and shares a close proximity to nature. However, city communities are often exposed to elevated levels of contaminants as compared to other areas, due to current and past urban and industrial activities (McBride, 2010). Thus, the use of urban garden soils with an unknown or suspect history, or those that remain in close proximity to ongoing release of potential contaminants (e.g., near a busy road) should be approached thoughtfully. In order to maximize the positive effects of urban gardening experiences, it is important to be aware not only of the potential benefits of urban gardens (e.g., improved mental health, improved food security, and improved nutritional health) but also of the risks that may be present in community gardens often caused by anthropogenic contamination by potentially hazardous substances. The effort here is not to frighten people out of eating and growing urban grown foods, but rather to communicate potential risks as necessary to promote health and garden productivity through educating gardeners on best gardening practices. This information should be presented in a clear, concise manner that helps gardeners limit exposure and risk to contaminants.

Two major exposure routes associated with urban gardening are direct ingestion of soil adhering to crops and eating produce that has sorbed contaminants from the soil into their tissues (Leake, 2009). Soils in urban environments can often have elevated levels of metals, and urban soil contamination can be an important source of metal intake by children (Nabulo, Young, & Black, 2010; Oliva & Fernandez Espinosa, 2007; Vrscaj, Poggio, & Ajmone Marsan, 2008). The use of lead in gasoline was widely practiced until 1986 when the primary phase-out of lead from gasoline was complete. Nonetheless, exposure to lead remains common through contact with urban soils because lead is persistent in the environment and can be dangerous even at low levels of exposure (Lah, 2011; Leake, Adam-Bradford, &

Rigby, 2009). However, even with the growing number of studies conducted on urban gardening and the expansive number of studies characterizing the effects of lead, relatively little information is available on the extent of human exposure to lead through urban gardening (Nabulo et al., 2010). Gardeners need not fear an ever present danger but they should adhere to simple practices and behaviors of limiting exposure as a means of being safe rather than sorry.

Anchorage does not have the population density of larger cities, but it does share many of the factors that contribute to soil contamination. Paints (e.g., lead prior to 1978), automobile traffic [e.g., lead prior to 1986; zinc, and polycyclic aromatic hydrocarbons (PAHs)], and commercial and industrial sites [e.g., PAHs, benzene, toluene, ethylbenzene, and xylenes (BTEX), solvents, lead, and other heavy metals] are all possible sources of contamination (Heinegg, Margos, Mason, Rabinowicz, Stracini, & Walsh, 2000; Lah, 2011). The primary mechanisms of contaminant transport to urban garden sites include atmospheric deposition (Oliva & Fernandez Espinosa, 2007), surface runoff, subsurface drainage (Wegner and Yaggi, 2001), and the mechanical mixing, movement, and manipulation of urban soil (Vrscaj et al., 2008).

1.5 Lead

A national survey conducted in the UK concluded that cities often have much higher lead concentrations in their soil than agricultural areas (Leake et al., 2009). Even with the decrease of industrial and vehicle lead emissions, lead enriched particle matter is still the main source of lead soil contamination on a global scale (Uzu, Sobanska, Sarret, Munoz, & Dumat, 2010). Many of the previously mentioned sources of contamination such as pre-1978 paints, fuel exhaust (prior to 1986), lead piping, and commercial and industrial by-products are all thought to contribute to the ubiquitous presence of lead in urban soils because of lead's persistence in the environment (Clark, Hausladen, & Brabander, 2008; Heinegg et al., 2000; Lah, 2011; Leake et al., 2009).

Lead exposure is a major health concern, but many study findings related to urban gardening and lead are optimistic. Leake et al. (2009) found even studies involving heavily contaminated urban allotment sites found no adverse health effects from gardening. In fact, many studies have found that plant uptake of lead is minimal due to a common attribute of urban soils – enrichment with "black carbon" which binds strongly to most organic and inorganic pollutants, retarding soil-to-plant transfer of contaminants (Leake et al., 2009). This indicates that the true risk of oral ingestion comes from improper washing of harvest resulting in ingestion of lead adhering to the surface of the produce or ingestion of soil directly (Lah, 2011; Leake et al., 2009). Leake et al. (2009) strongly encourages the continual use of risk assessments for gardens in urban areas, and while findings are often optimistic, some produce such a leafy greens, sunflowers, and beans have been shown to accumulate lead, risk of direct soil ingestion may exist (particularly for youth), and insufficient washing of produce may occur (Clark et al., 2008).

1.6 Emissions

Air quality in the cities of industrialized nations is most affected by traffic emissions (Buczynska et al., 2008). Benzene, toulene, ethylbenzene, and xylenes (BTEX) is most notably emitted through vehicle emissions (Truc and Oanh, 2007). A traffic study of BTEX compounds conducted in Belgium found that the source of all BTEX compounds in a square study area of Antwerp could be linked to road traffic (Buczynska et al., 2008). The BTEX chemical combination presents an area of concern for urban gardens because some BTEX compounds are highly reactive volatile organic compounds (VOCs) capable of interacting with secondary air pollutants, are ubiquitous in urban environments, and are known to be toxic and genotoxic (Truc and Oanh, 2007). Of three roadways with high traffic, low traffic, and traffic through an industrial estate found that rush hour traffic peaks were the major source of BTEX measured in the study (Truc and Oanh, 2007).

Nevertheless, the health benefits of eating fruits and vegetables, physical activity, and outdoor exercise can all be achieved through the practice of urban gardening (Leake, 2009). Many studies have found these benefits outweigh either the risk of contaminant exposure or the amount of exposure (Leake et al., 2009; Oliva and Fernandez Espinosa, 2007). However, the limited data available in reference to the effects of exposure to soil and plant contaminants in urban gardens, the importance of soil and plant evaluation for garden management and planning, and in the interest of the well-being and health of the community, it is well worth the time and effort of inquiry to understand gardening soil to keep urban gardens as healthy and safe from risk as possible.

Keeping gardeners healthy, aware, and informed on the issues of urban soil contamination presents a new challenge. Soil contamination is a very complex and dynamic phenomenon that many gardeners may not be equipped or motivated to learn. Scientific communication itself is a complex topic that encompasses an assortment of issues from factual dissemination of scientific research and new models of public engagement to the most basic barrier of scientific versus mainstream language (Bubela et al., 2009; Weigold, 2001). In an article from *Nature Biotechnology*, the scope by which technology has transformed the nature of the media system greatly influences how the public informs themselves about science and its social implications (Bubela et al., 2009). However, the article warns that while these new outlets offer highly motivated individuals a great ability to learn about science and to become involved in decision making, media fragmentation has also meant that individuals that lack an interest in science can very easily avoid the information altogether (Bubela et al., 2009). Finding time to learn about and practice gardening is often challenge enough for many individuals and throwing an understanding of soil contamination on top of gardening may not be a high priority. Without an awareness and appreciation of urban soil contaminants, transport mechanisms, and exposure routes, limiting exposure will be a challenge. Many Cooperative Extension agencies house data on soil contamination, and journal articles address the risks associated with concentration of various contaminants in parts per billion (ppb), parts per million (ppm), milligrams per kilogram (mg/kg), or micrograms per gram (μg/g) but this does little to limit the amount of worry and exposure an urban gardener might experience. There are many sources available on healthy behaviors to limit exposure, but these do little to help inform about the concerns of contamination if gardeners are unaware of them or do not fully understand their content.

The creation of regionally-specific educational resources that address urban gardening issues clearly, concisely, and comprehensively by explaining soil contamination, soil testing for contamination, how to interpret results, and healthy behaviors for avoiding exposure and limiting risk is especially important during this current resurgence of public interest in urban gardening.

1.7 Significance of the Project

Public health is an all-encompassing practice, including the interplay between the natural environment and human health. With urban gardening there is a very close connection between the natural environment and health. However, in urban gardening there is also a suite of secondary factors that may play major roles in overall health outcomes. The built environment surrounding a gardening space and the social environment surrounding urban gardening practices connect with other factors such as cultural factors, socioeconomic factors, and food processing to further the complexity of urban gardening. However, a common principle found across many public health disciplines is that simple interventions can often be the most effective for improving health. Indeed, Fresco (2009) implies this same sentiment in food system sustainability with his “small is beautiful” incarnation. The health of the environment seems a perfect example of this simplicity and its effect on human health. While the issues facing an environment's health can be very complicated and ever more so once human health is added to the equation, the simple truth still remains that improving the health of the environment improves the health of humans. It is because of an interest in environmental health and its relationship to human health that this project negotiates public health issues grounded in environmental health. The project is about people, gardeners to be more specific, but it does highlight an issue about the anthropogenic contamination existing in the urban environment. It can be argued that currently urban gardening is not a game changer in terms of climate change relief, and there are far more dire situations existing that threaten environmental and human health, but addressing urban gardening is a simple step forward toward a bigger world and health issue. Fostering sustainable food systems, environmental stewardship and conservation, and promoting health through the practice of urban gardening can be an instrumental cog in the implementation of more sustainable and environmentally friendly food systems. Gardening is such a simple and small step to take in terms of promoting human health and environmental stewardship. Its greatest impacts are most certainly reserved for those directly benefitting from improved nutrition and physical activity through gardening. In a community sense its effect may never transition to a bigger part of the extended community of a city and thus only benefit the community directly involved in a gardening program, but this simple endeavor can eventually add up to improve more than just one individual gardener's or community's health. Through many avenues, such as alleviating food cost in local areas to cutting down on the transportation of foods from one region to another, urban and community gardens can help improve food security and provide economic benefits to the entire population of a region. Small victories are victories nonetheless, and the promotion of human health can use as many victories as possible. The outcome of this project will be lucky to be considered a small victory for benefiting the health of gardeners in urban settings.

Although it is only a small step toward improving the greater issues facing community gardening in Alaska and Anchorage, this project has brought to light some of the discussion points and issues currently surrounding community gardening in Anchorage and created a product that can help support behaviors that allow gardeners to reduce exposure and risk through their urban gardening practices. The guide compiles information about gardening in urban soils from already existing sources into one concise and easy to read guide for public use in order to make soil contamination more understandable to all urban gardeners. Much of the information regarding soil and water contamination can be difficult to interpret for those without science backgrounds. Information found often begets more research into how various chemical interactions occur in various settings. Lab testing results are another area of soil contamination information that can be difficult for some to understand. By breaking down the bare essentials of what a gardener would need to know in order to identify contamination sources, protect him/her from contamination, know when to test, and understand lab results, the issue of soil contamination becomes a much less daunting topic. With a down-to-earth approach, gardeners can be armed with knowledge that can empower them in their efforts to benefit their health through urban gardening. In addition, the preliminary research that has gone into this project can serve as groundwork to help others in the quest to continue research in the area of community gardening in Anchorage and throughout Alaska. The discussion and reflection of this experience will offer anyone interested in researching sustainable food systems, urban agriculture, community gardening, and food security in Alaska with recommendations on the areas that need to be addressed and researched.

1.8 Community Partner: Alaska Community Action on Toxics (ACAT)

Alaska Community Action on Toxics (ACAT) served as the community partner for this project. As a statewide environmental health and justice organization, ACAT has been present in Alaska for 18 years. Their mission statement is: *"Our mission is to assure justice by advocating for environmental and community health. We believe that everyone has the right to clean air, clean water, and toxic-free food."* Alaska Community Action on Toxics works to help communities implement effective strategies to limit their exposure to toxic substances, protect and restore ecosystems, eliminate the production and release of chemicals, ensure the public's right to know, support the rights of Indigenous peoples, and achieve policies based on the precautionary principal.

Chapter 2: Research Methods

2.1 Goal, Aims, and Objectives

The following were the goal, aims, and objectives of the project.

Goal:

- Create a guide that provides information regarding urban gardening as it relates to health.

Aims:

- Gain experience in soil and plant sampling and analysis, so as to inform development of the guide.
- Conduct a preliminary study of Anchorage's community gardens.

Objectives:

1. Collect soil and plant tissue samples for analysis of urban soil contaminants.
2. Recruit participants whose background includes organizational and developmental community garden experience.
3. Conduct interviews with study participants.
4. Analyze qualitative data through interview coding to distinguish core categories pertaining to Anchorage's community gardens.

2.2 Soil and Plant Tissue Sampling

Soil and plant tissue sampling was an informative aspect to the project design aimed at stimulating practical research experience for the practicum that could then be incorporated into development of the guide. While the analytical data resulting from this research did not make their way into the final *Understanding Urban Soils Guide*, the planning and implementation of soil and plant sampling informed development of the soil testing portion of the guide and served further usefulness in enhancing the practicum learning experience.

Methods utilized in this study were taken from the standard operating procedure (SOP) of the Applied Science, Engineering, and Technology (ASET) Laboratory's Acid Extraction of Sediments, Sludges, and Soils. This SOP is based on the Environmental Protection Agency's (EPA) Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies, and was written by Dr. Birgit Hagedorn.

Soil and plant tissue sampling was conducted at the C Street Community Gardens located at the corner of West 19th avenue and C Street in Anchorage, Alaska. C Street is the busier of the two streets and it is located to the east of the garden, running north and south and serving as a major roadway connecting Anchorage's midtown and downtown districts. West 19th Avenue is located to the north of the garden and is the street that allows access to the garden's parking lot. West 19th avenue is a single east side entry/exit point for a small neighborhood framed in from Artic Boulevard to the west, 18th avenue to the north and 20th avenue to the south. The C street garden location was chosen for its more ideal representation of an urban garden located proximally to a common urban contamination source.

A 4x4-sampling grid was used to ensure that an accurate representation of the garden's soils was sampled. This grid also allowed for a manageable number of soils and plant tissue samples to be taken. Soil samples were collected with the use of a soil auger. Sampling sites in each block were selected based on ease of access for sample collection. Only plots being used for gardening during the time of sampling were used. Soil cores taken from the first three inches of soil were collected for each grid block. Samples were collected from multiple areas in each grid block to account for contamination variances. These samples were combined to comprise a composite sample of each grid block. Soil samples were each stored in separate labeled and sealed Ziploc storage bags. After each sample, the auger was rinsed with distilled water and dried to prevent cross sample contamination. Plant tissue samples were also taken from plots actively in use during the time of sample collection.

Samples were collected late in the growing season, however, so plant tissue samples could not be collected for every grid block. When available, multiple types of plant samples were taken from the sample plot. Plant tissues samples were stored in individual labeled and sealed Ziploc bags. Figure 2 and Figure 3 represent the C Street Garden. Figure 2 shows an aerial view of the garden. Figure 3 shows the sampling grid used to indicate where the samples were collected from the garden.

Sample numbers were designated in the order in which the samples were collected, with “Sample 1” being the first sample collected and “Sample 16” being the last. Plant tissue samples were collected based on availability. Thus, some sample areas were left without plant tissue samples being collected. The type of produce collected was based on the produce present within the sample area. For sample areas that contained multiple plant types, multiple samples of produce were collected. Grid blocks in which plant tissue samples were collected and filled-in yellow.

Figure 2. Aerial view of the “C” Street Gardens.

Sample 16	Sample 9	Sample 8	Sample 1
Sample 15	Sample 10	Sample 7	Sample 2
Sample 14	Sample 11	Sample 6	Sample 3
Sample 13	Sample 12	Sample 5	Sample 4

Figure 3. Soil and plant tissue sampling grid (soil collected from all sites; plant tissue also collected from yellow sites).

The sample number is the identifier used to label each sample collected. Both plant and soil samples are labeled with the sample number and plot numbers on them. In some instances more than one type of plant tissue was collected. These plant tissues were further identified with indicator letters as needed ranging from A through C.

2.3 Soil and Plant Tissue Analysis

Soil and plant tissue samples were analyzed by inductively coupled plasma mass spectrometry (ICP-MS) for the presence of heavy metals. Sample analysis of both soil and plant tissues was conducted at the ASET Lab. Sample preparation followed the standard operating procedure of the ASET Lab for the acid extraction of sediments, sludges, and soils concurrent with EPA Method 3050B (EPA, 1996). The ASET Lab manager Dr. Birgit Hagedorn conducted all sample analyses.

The primary investigator completed all sample preparations before analysis. Sample preparations were split between the Environmental and Health Sciences Teaching and Research (EHSTR) Lab and the ASET Lab. All samples were transported in sealed airtight containers and were moved directly from the EHSTR Lab to the ASET Lab.

In the EHSTR Lab prior to sample analysis, soil samples were air dried and sifted. Plant tissue samples were dried using an oven set to 82 degrees Celsius for two days. Samples were then weighed and placed back in the oven for another two days. After four days total in the oven, samples were once again weighed to ensure the tissues had reached a constant weight between measurements. Samples were then placed in sealed Ziploc bags. Table 1 shows the dry weight measurements of the plant tissue samples after two days in the oven on November 2nd, 2012 and after four days in the oven on November 4th, 2012. Those that were chosen for plant tissue analysis are indicated in yellow. With a limited amount of ASET Lab time available, four samples were selected for ICP-MS analysis. It was determined that the far south end samples would be tested as a way of providing a worst case scenario analysis. Because “Sample 4” came from the grid block closest to C street, it was determined that it would be a good indication of worst case scenario contamination levels. Samples 5, 12, and 13 were also selected as they were collected progressively further away from C Street and could indicate variations in contamination distribution that would be an indication of further samples needing to be analyzed.

Table 1

Dry Weight Plant Tissue Samples (samples in yellow were analyzed)

Sample Source	Date 11/2/2012	Date 11/4/2012
Sample 3A	15.6311	15.6165
Sample 3B	9.0143	9.0243
Sample 4A	14.7671	14.7402
Sample 4B	22.2807	22.2472
Sample 5	3.4703	3.4622
Sample 6	2.925	2.9122
Sample 7	12.2779	12.2664
Sample 9A	11.2181	11.2024
Sample 9B	15.36454	15.647
Sample 9C	12.611	12.61
Sample 10A	2.3391	2.3391
Sample 10B	13.8865	13.8789
Sample 13	21.7521	21.7411
Sample 16	16.0188	16.0124

Soil samples identified for analysis were further sifted and separated to obtain the best soil aggregate size for analysis. A mortar and pestle was used to prepare the dried plant tissues samples for analysis. Plant tissue samples for Sample 4 were combined to make one composite sample for analysis (Table 2). Instruments were cleaned between each use with distilled water and a bristled brush. After each cleaning the mortar and pestle were then rinsed in distilled water and dried before preparation of another sample.

Table 2

Plant Tissue Type

Sample source	Type	
Sample 4	Carrot	Green onions
Sample 5	Carrot	N/A
Sample 13	Red Leaf Lettuce	N/A

Soil and plant tissue samples were then weighed and placed in labeled centrifuge tubes. Soil samples were measured out to 5 grams with a 0.5 gram allowable measurement range. Plant tissues samples were measured out at 1 gram with a 0.5 gram allowable measurement range. Sample analysis was then carried out using an Agilent Technologies 7500c ICP-MS equipped with the octopole reaction system.

Figure 4 indicates which samples were ultimately selected for laboratory analysis. Figure 4 represents the same sampling grid as Figure 3, however in Figure 4, green blocks serve as indicators for those samples selected for laboratory analysis.

Sample 16	Sample 9	Sample 8	Sample 1
Sample 15	Sample 10	Sample 7	Sample 2
Sample 14	Sample 11	Sample 6	Sample 3
Sample 13	Sample 12	Sample 5	Sample 4

Figure 4. Location of samples ultimately selected for analysis.

The analytical method is based on EPA Method 200.8 (EPA, 1994), allowing for quantification of total recoverable elements in wastewater, sludges, and soils. Table 3 shows the analytes that are included in the standard suite of trace elements determined in Method 200.8 analyses. Table 3 represents the trace elements most often included in Method 200.8, with the addition of non-trace elements that may be included in final digestion.

2.4 Community Garden Study Participant Sampling

In order to gain information on community gardens activities in Anchorage, the study design included the use of key informant interviews. Key informants were enrolled in the study through the initial use of purposive sampling, followed by snowball sampling. Through the help of the project committee members and Julie Riley, a horticulturalist with the University of Alaska Fairbanks (UAF) Cooperative Extension Services, initial contacts were made with possible interviewees.

Andrew Cutting is the director of Nonprofit Research and Partnerships at The Foraker Group. In addition to his hands on efforts in developing the Gardens at Bragaw, Mr. Cutting brought expertise in the area of partnership coordination and organization. His background in organization and community outreach along with his current work with The Foraker Group gave his insights into Anchorages community gardens a strong organizational and community building focus.

Nick Moe was the Sustainable Communities' Coordinator at Alaska Center for the Environment (ACE). The Alaska Center for the Environment has played a crucial role in creating the coastal trail, helping establish the Chugach State Park, and start projects such as recycling in Anchorage. The organization has begun to take on food security and local food issues. Mr. Moe also serves on the Governing Board of the Alaska Food Policy Council (AFPC), which helps inform policy makers on policy recommendations to improve food

Table 3

200.8 EPA Analytes

	Element Name	Element Symbol	LOD ppb
Trace Elements EPA 200.8 Validated	Antimony	Sb	1.5
	Arsenic	As	0.5
	Barium	Ba	0.7
	Beryllium	Be	0.04
	Cadmium	Cd	0.5
	Chromium	Cr	0.8
	Cobalt	Co	2
	Copper	Cu	1.5
	Lead	Pb	0.4
	Manganese	Mn	1.4
	Mercury*	Hg	
	Molybdenum	Mo	0.8
	Nickel	Ni	0.8
	Selenium	Se	0.8
	Silver	Ag	0.8
	Thallium	Tl	1
	Thorium	Th	0.8
	Uranium	U	0.8
	Vanadium	V	1
	Zinc	Zn	0.7
Non-Trace Elements	Aluminum	Al	0.8
	Calcium	Ca	70
	Iron	Fe	20
	Magnesium	Mg	20
	Potassium	K	30
	Sodium	Na	26
	Silicium*	Si	xxx

* Mercury and Silicium were not analyzed in the "C" Street Gardens soil and plant tissue samples and they do not have a LOD

security in Alaska. Mr. Moe provided a perspective on food security issues and community coordination that was very beneficial in bringing insight into the project on those topics.

GeorgeAnne Sprinkle was the organic gardening coordinator at ACAT. She has been gardening professionally in Anchorage since 1998 and has a great wealth of local gardening experience. Through her work with ACAT, Ms. Sprinkle gardened, educated, and organized community gardening programs such as Yardicopia. Yardicopia is an ACAT-based gardening program created by Ms. Sprinkle that helps connect gardener to gardening space, offers educational opportunities, and fosters organic, sustainable, and community based gardening. While her work with ACAT certainly gave her experience in the community and organizational categories as well, Ms. Sprinkle brought a wealth of gardening knowledge to the group of key informants and had a great gardeners' perspective on many of the organizational pitfalls of the community gardening system.

As can be seen from their titles and backgrounds all three key informants have established relationships with Anchorages community gardens. This helped in tying their collective knowledge together in an impactful way that directly relates to Anchorage and Alaskan community garden efforts. In short, their close connection to Anchorage's community gardens is a paramount component to them being selected as the key informants for the interviews, however; it is their varying channels or interaction within the Anchorage's community gardens that lends the group as a whole a great amount of experience and insight.

2.5 Institutional Review Board (IRB)

To ensure the protection of study subjects, the UAA Institutional Review Board (IRB) reviewed the initial study proposal entitled "Supporting Community Gardening in Alaska through Development of a Community Garden Practice Guide," the interview consent form (Appendix A), and the key informant interview questions (Appendix B). The project was approved on August 27, 2012 (354358-1).

2.6 Interview Process

All key informant interviews were conducted between the dates of February 1st, 2013 and March 4th, 2013. Interviews were conducted by phone and recorded on a digital recorder. Key informants were asked to review and verbally agree to the consent form, and then were presented with seven open-ended questions focusing on the improvement of the community garden experience so that the information could be utilized for the development of a guide. Interviewees were asked to describe any previous and current community gardening ventures they were associated with before the questions proceeded. Upon initiation of the interviews, the key informants were free to address each question without being led in any specific direction by the interviewer. Non-scripted clarifying questions were asked during the interview process, but these questions were only asked when deemed necessary to clarify an interviewee's point, use of unfamiliar subject, or to clarify a response. Interviews ranged from roughly 15 to 26 minutes in length. Interviews were then transcribed from the digital recording. After the transcriptions were complete, the transcriptions were read through while the recorded interviews were running to ensure that the transcriptions accurately depicted the recorded account. Interviews were also listened to at least twice, so that the coding interpretations could begin to be formed from the content and context of each interview.

2.7 Qualitative Analysis of Key Informant Interviews

A summative content analysis approach was used, by which the investigator compared keywords and content while interpreting the underlying context of the responses. Coding for the interviews was completed in two stages. The first stage involved utilizing open coding to compare and categorize data into concepts to examine, compare and conceptualize (Bryman, 2008). After forming categories, selective coding was then implemented to relate concepts into one cohesive system or 'core category' that served as the central concepts present in the interviews (Bryman 2008). Open coding, which Bryman

(2008) defines as “the process of breaking down, examining, comparing, conceptualizing, and categorizing data”, naturally came about through the study process. Because the responses elicited were significantly different in nature than what was anticipated, the data needed multiple passes by the investigator to find concepts for summarizing the data. This occurrence potentially helped to stave off any investigator biases. Selective coding continued to build directly from the data while a coding manual was designed as the open coding was being carried out. This allowed the concept ideas derived from the interviews and the coding manual to take form together. Effort was put forth to have mutually exclusive categories in the open coding process in order to draw clear lines between each concept (Bryman, 2008). Striving to have mutually exclusive categories helped keep the coding conclusive, however due to the minimal amount of interview material and the relative nature of the responses, some overlap can be debated in some codes.

2.8 Qualitative Limitations

Qualitative study limitations were the low number of interview participants, as well as the inherent risk of interview and coder biases that all qualitative studies encounter. However, as mentioned previously, the use of a single interviewer and coder for the study does increase the consistency of interviewing and coding. It is important to note that while there was a limited number of interviewees, their knowledge and experience with the subject matter was helpful in representing a view that is consistent with the population they closely work with. With a heightened awareness of the issues facing urban gardening in Anchorage and Alaska as compared to the general population they represent, the key informant interviewees were a thoroughly informed group that had a great impact on the project. This more informed knowledgebase of the community gardening system currently being employed in Anchorage is likely the factor most largely responsible for the unexpected concepts found in the interview responses. While the study originally aimed at interviewing a larger sample size of community gardeners, it is possible to argue that this group of interviewees provided greater insight into organizational, infrastructural, and community building challenges than a sample of gardeners from the community might have.

2.9 Guide Development Methods

Development of the guide was collaborative process with ACAT and Ms. GeorgeAnne Sprinkle. Through the development of the interviews and literature review, the guide began to take on a more narrow focus that was less gardening-specific and more soil and testing specific. As this occurred, it seemed to fit much more intuitively with ACAT's mission of limiting exposure to toxins.

Guide development was initially informed through the sampling and testing procedures undertaken for the project research. From there, preexisting guide designs were studied and used to inform layout of the guide. Multiple outlines served as the initial starting point of the guide. As the community partner representative from ACAT, Ms. Sprinkle helped inform the development of the guide with critical development strategies and feedback progressing the development of the outlines into a working guide. Ms. Sprinkle played an especially prominent role in defining the topics to be covered from other guides. Topics such as addressing land use history from a home owner and gardener's perspective and limited resources and time were greatly influenced by Ms. Sprinkle and her expertise. Ms. Sprinkle also played a crucial role in maintaining the scope of the guide. As the main purpose of the guide was to couple information more commonly covered in soil contamination guides with supplementary and often harder to find community gardening components, the guide had to balance being comprehensive, but not overwhelming. Each stage of the guide development was passed through Ms. Sprinkle to make sure it kept with ACAT's core values and retained a desirable level of compressive information.

Once the vision for the guide had been set, content was first developed in Microsoft Word. This information was then passed between the investigator and Ms. Sprinkle for edits and redrafts.

Chapter 3: Research Results

3.1 Laboratory Analysis

In Tables 4 (soil) and 5 (plant), the results of each C Street Gardens sample's element concentrations are displayed. A blank sample along with a duplicate of Sample 4 was used for quality control monitoring. The Limit of Detection (LOD) for each element is listed in the LOD sample column. All compounds for which peak limits were detected, but were below the LOD, are reported as <LOD. According to most urban gardening literature, lead may be the most important contaminant to pay attention to, as it is most commonly detected and the health impacts can be significant. Lead soil concentration analysis results ranged from as low as 19.57 mg/kg, indicated in the Sample 4 duplicate, to 21.77 mg/kg in Sample 13. This produces a maximum difference between highest and lowest soil samples of 2.20 mg/kg in the samples selected for analysis, which is comparable to the difference in concentrations measured in the duplicate samples labeled Sample 4 (21.63 mg/kg) and 4D (19.57 mg/kg). Plant tissue analysis of lead results ranged from 3.69-4.19 mg/kg, markedly lower than the soil concentrations.

Table 4

Soil ICPMS Results

Sample	LOD	Blank	Sample 4	Sample 4D	Sample 5	Sample 12	Sample 13
Unit	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}
<u>Analyte</u>							
Aluminum	0.09	<LOD	0.33	0.32	0.33	0.37	0.34
Antimony	22.60	<LOD	316.67	301.32	297.07	394.63	430.39
Arsenic	14.63	<LOD	6001.51	5563.74	5971.31	6149.91	6315.40
Barium	0.17	1.44	12266.66	11660.17	12113.39	13277.13	13380.70
Beryllium	18.63	<LOD	683.92	650.49	577.63	752.20	1038.21
Cadmium	11.15	<LOD	8241.47	8189.57	8298.04	8934.56	9561.54
Calcium	0.05	<LOD	39.73	38.97	38.63	41.47	42.91
Chromium	0.23	<LOD	20.27	20.45	20.46	23.73	21.87
Cobalt	0.13	<LOD	379.07	360.84	359.03	345.57	351.87
Copper	4.65	<LOD	14951.63	15021.47	14913.96	15226.85	16011.49
Iron	0.19	<LOD	6.65	6.37	6.26	7.14	7.25
Lead	0.06	3.81	21.63	19.57	20.22	21.39	21.77
Magnesium	0.13	<LOD	16.15	16.77	16.10	18.54	19.71
Manganese	0.70	<LOD	39.62	37.34	37.66	45.61	46.42
Molybdenum	0.11	<LOD	6.76	6.84	6.51	4.52	5.13
Nickle	0.15	<LOD	0.18	0.19	0.15	0.17	0.18
Potassium	0.06	<LOD	1.03	1.05	0.95	0.77	0.81
Selenium	0.05	<LOD	0.08	0.08	0.07	0.13	0.08
Silver	0.03	<LOD	0.12	0.12	0.11	0.20	0.21
Sodium	0.08	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Thallium	0.09	<LOD	102.92	100.84	92.74	109.11	103.25
Thorium	0.47	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Uranium	0.25	<LOD	8.60	8.21	7.51	20.89	18.54
Vanadium	0.14	<LOD	1.63	1.43	1.33	1.37	1.38
Zinc	0.11	<LOD	0.72	0.68	0.56	0.68	0.72

Table 5

Plant Tissue ICPMS Results

Sample	LOD	Sample 4	Sample 4D	Sample 13	Sample 5
Unit	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg/kg
Analyte					
Aluminum	0.02	<LOD	0.06	0.06	0.06
Antimony	4.52	<LOD	61.37	56.85	57.24
Arsenic	2.93	<LOD	1163.08	1049.76	1150.54
Barium	0.03	1.44	2377.26	2200.03	2333.99
Beryllium	3.73	<LOD	132.54	122.73	111.30
Cadmium	2.23	<LOD	1597.18	1545.20	1598.85
Calcium	0.01	<LOD	7.70	7.35	7.44
Chromium	0.05	<LOD	3.93	3.86	3.94
Cobalt	0.03	<LOD	73.46	68.08	69.18
Copper	0.93	<LOD	2897.60	2834.24	2873.60
Iron	0.04	<LOD	1.29	1.20	1.21
Lead	0.01	3.81	4.19	3.69	3.90
Magnesium	0.03	<LOD	3.13	3.16	3.10
Manganese	0.14	<LOD	7.68	7.05	7.26
Molybdenum	0.02	<LOD	1.31	1.29	1.25
Nickle	0.03	<LOD	0.03	0.04	0.03
Potassium	0.01	<LOD	0.20	0.20	0.18
Selenium	0.01	<LOD	0.02	0.01	0.01
Silver	0.01	<LOD	0.02	0.02	0.02
Sodium	0.02	<LOD	<LOD	<LOD	<LOD
Thallium	0.02	<LOD	19.95	19.03	17.87
Thorium	0.09	<LOD	<LOD	<LOD	<LOD
Uranium	0.05	<LOD	1.67	1.55	1.45
Vanadium	0.03	<LOD	0.32	0.27	0.26
Zinc	0.02	<LOD	0.14	0.13	0.11

3.2 Limitations

The purpose of the lab analysis was to test a small portion of what was collected to indicate if further testing may be warranted. Based on the scope of the study, this purpose was met but is attached to the following limitations.

Organic contaminant assessment was not possible in this study. This meant that some of the contaminants covered in the literature reviews, such a BETX, were not analyzed for this study. This leaves room for future study and testing on these compounds in Anchorage's community gardening soils. Testing of organic contaminants is highly recommended for future studies.

As Table 4 indicates, soil sample analysis is fairly consistent across the controls and the samples. However, in looking closely at the table, it is clear that in the plant tissues samples there are some inconsistencies. Sample 4 and the sample 4 duplicate indicates drastically differing results for many of the analytes, and no doubt limits what information can be taken from the results in Table 5. The nature of this project and the lab time allotted did not leave much opportunity to investigate these issues or for retesting the samples.

A limited number of samples were collected, and an even smaller number of these samples were chosen for analysis. With regard to the purposes of this project, the samples and analyses conducted served their purpose well, however, limitations arise from the small number of samples tested. Missing plant tissue samples to pair with the Sample 13 soils sample limit what can be concluded regarding the amount of contamination in the plant tissues. In addition, the counter-intuitive results of lead concentrations being higher in plots furthest from the street is an interesting scenario that ,without further study, limits what can be implied from the results.

3.3 Interview Analysis

Interview analysis started with many repeat play backs and rereading of the interview transcripts, resulting in the development of two primary codes: “Improving Governance” and “Mobilizing Community Actions”.

“Improving Governance” was the first code to be created. It was felt that through the tone of the interviews and the substance to many of the responses that all the key informants felt a real need for various forms of an improved governmental system for Anchorage’s community gardens. Themes of improved management, better organization, creation of an organization, establishing education, and establishing cross garden relationships all played into forming the “Improving Governance” code.

“Mobilizing Community Actions” was then created from responses that indicated a need for building a stronger base in this community of Anchorage community gardeners. Many of the “Mobilizing Community Actions” themes seem to fall directly under the “Improving Governance” primary code, but the tone of many of the interview responses referring to establishing more gardening space, improving infrastructure, and mobilizing a community representation, seemed to indicate more of a preliminary step to establishing a community that warrants an improved governmental structure. For further clarification, in looking through the interviews it seemed that when a key informant addressed building more gardening space, it often had less to do with having a community garden organization established and more to do with the individuals and communities wanting that extra gardening space finding a way to create a movement to voice demand. This appears to be an issue that could be perfectly carried out with the help of a community gardening organization or governing body to help present this hope and demand for more gardening space in the city, but as Anchorage’s community garden system stands right now that “Improved Governance” cannot materialize out of nothing. The community has to initially mobilize itself to improve representation and once this has been done the community can begin to coalesce into some semblance of community gardeners' collective.

The two primary codes were each characterized by three sub-codes. Each code and the number for sub-codes gathered for each is represented in Table 6. The number of times a sub-code was used alone is not a clear indication of that code's relevance to the study. "Management" was far and away the most used sub-code; however, "Organization" was the most emphasized sub-code relating to the primary-code "Improving Governance," even though the number of references to "Organization" was the least common of the "Improving Governance" sub-codes.

Table 6

Coding Distribution

Primary-Code	Sub-Code	Number of References
	Management	9
Improving Governance	Education	8
	Organization	6
	Outreach	5
Community Action	Space	4
	Infrastructure	3

Based on the collective responses of the key informants, "Improving Governance" was clearly the most prominent issue. This can be seen by looking at the total amount of references to improving governance through the sub-codes with 24 total references to the three sub-codes "Management," "Education," and "Organization" while the sub-codes for mobilizing community action "Space," Infrastructure," and "Outreach" were referenced 12 times. Contextual clues from the interviewees' verbal responses also reflect this emphasis on "Improving Governance."

The importance of "Improving Governance" over "Community Action" is twofold. For one it is clear that lack of an organizational body and governance was every respondent's main concern with the current issues facing urban gardening in Anchorage. It can also be seen through the responses that in order to gain more gardening space, create better infrastructure, and increase outreach across the community, the respondents believed that initially a true organizational body be present. To be thorough, each respondent gave a clear view of a desired future where there is an organizational body in place dedicated to Anchorage's community gardening that could provide management for Anchorage's community gardeners, a more organized route to improving gardening spaces, applying for gardening spaces, championing a community driven organization, and helping the community advance as its needs grow.

3.3.1 Improving governance. Based on the interview responses and coding used, "Improving Governance" was the most agreed upon need for the Anchorage community garden community. While one informant in particular seemed to think that onsite gardening management was the most important issue, the other two informants seem to think alike in overall organization being the main focus. Indeed, in looking through the responses, the researcher agrees that organization seems to be the most important issue, above all other items addressed, including management of the gardens. This would be most easily and likely accomplished through creating a better and perhaps more universal organizational structure for Anchorage's community gardening. In this manner, organization will then work its way to more personalized management of the gardens. Management had a large number of references largely because each respondent hit on the topic. This was accomplished in three primary ways. First, was a straight forward approach of stressing the need for more management of the current gardens.

> "Well, I mean what you are talking about to me is actually having the Muni step up and manage the garden."

This is a straight forward assertion that the community gardening experience and efficiency would be improved with onsite management by individuals qualified to do so. References to management, such as the example given above, drove the number of "Management" codes higher; however, when taken in their larger context of an entire interview it is clear that the "Organization" needed for simple onsite management of the gardens in greatly needed. For one, an organization need be in place to organize (within reason) consistent management from manager to manager and from garden to garden. Also, the need for locating, vetting, and possibly paying managers would require an organized body capable of effectively doing so.

Secondly, management was spoken about as it relates to an overarching organization.

> "You see that a lot of people are passionate about gardening, but they are not passionate or knowledgeable about keeping an organization going"

Much like the example above, this reference to management of the people making up the community's gardeners indicates a need for management at a personal level. It indicates that someone needs to be in place to help gardeners keep their gardening communities operating at a functional level. Furthermore, the example given above is even more forthcoming in insinuating that for this management to take place, an organizing body with good operating systems be in place to carry out the task of helping each community manage its gardening and community needs.

Thirdly, interviewees referred to management as it relates to the last "Improving Governance" sub-code: "Education."

> "A lot of times there is not a lot of success because [there is] no one in there to pull it from."

Within the context of the interview, this statement indicates that management is needed for the communities in order to help them make use of educational resources that are available to them. "Education" is a sub-code all unto itself, but in this example we see the respondent less interested in creating educational uses and more concerned with how a physical management structure between the community and the organization can improve the use of already existing educational resources. It could also be argued, especially in the example provided above, that this statement should have been coded as "Organization", as improving the organizational system as a whole could and should lead to gardeners having clearer routes to these resources. However, in the context of the interview it is clear that the interviewee here is referring to gardeners lost in their gardening communities and having no one present to whom they can pose their questions.

"Education" as a sub-code relates back to "Improving Governance" mainly because all references were contextually linked to the management of the gardens or a byproduct of a more organized community garden system. The "Education" sub-code is also misleading in its total number of references, as many of them came in rapid succession in the interviews. The coding could have been paired as one "Education" code but was not based on slight differences in the intended educational content. That is to say that the educational tool or educational purpose differed even though the references were being stacked one on top of another in the response. An example of this would be the following two "Education" sub-codes, which followed each other within one respondent's answer:

> "Well I think watering is always an issue for people. Whether or not they just aren't there to water or they water anyways and overwater. Or if it is raining they just assume that the ground has adequate saturation. But you really have to be present and

inspect your soils to know. The time people do or do not spend in a garden. A lot of people don't realize that keeping your eye on it and spending a few hours each day makes a big difference."

Which was followed immediately by:

"When to weed. Some people wait until the weeds are big and that takes a lot more energy to weed. Instead of just doing a surface pull of the weeds and putting them back in your compost."

It can be seen in the first example that the respondent is thinking of two different educational needs, i.e., watering needs and time allotment needs. However, the respondent framed them within the same context as if to indicate that one is influenced by the other. Thus, the entire statement was coded as one single "Educational" code. In the second example, the respondent indicated weeding as a separate example of education gaps in gardeners' knowledge that needed to be addressed.

3.3.2 Community action. Once again, coding under the primary code of "Mobilizing Community Action" was somewhat difficult. This primary code ties in well with improving governance because mobilizing community action is often referred to as a means to creating more organization throughout the current community garden system or the need for a governing unit to facilitate mobilizing interest of more diverse individual, community, and organizations.

"Space" is an important sub-code of the "Community Action" primary code. This sub-code was highlighted by comments both on individual garden's uses of space as well as improvements in the amount of gardening space throughout Anchorage. Three great examples of respondents' thoughts on gardening space indicate a need for improving gardening space at a specific garden (in this case the C Street Gardens) and possibly improving the process by which the space is utilized, the limited number of plots throughout the city, and the philosophical and social responsibility to supply people with a means to grow their own food.

In the first example the respondent is speaking directly about issues facing the C Street Gardens and states:

> "It would be nice to have a better process because there is a waiting list and then some of the plots don't get cultivated."

This statement is a bit ambiguous as it could be argued that it is better suited in the "Management" sub-code, but this comment does deal directly with space and how there is a need for more of it. The researcher decided that this comment should be coded as "Space" because there is a waiting list regardless of how some plots are rented and then left fallow. The response indicates that pertaining to the C Street Gardens there is a bigger community interested in gardening at that location than the current garden can support. The respondent does go on to state that "Making the process more efficient, we had commandeered a plot next to us that was not being used and there were a couple of plots like that that you would like to see get use". The statement here is directed at improving management as it indicates a need for utilizing the space better and improving the operations at the C Street Gardens, which could be done through better management at the garden.

In the next response, there is a straightforward emphasis on a lack of gardening space available in Anchorage.

> "Once the Bragaw [garden] gets up and running you will only have about 140 plots in the whole city. So that is 140 families, 200 at the most. It is just a very small number"

Considering that many of the gardens in town have waiting lists, this statement introduces the idea of expanding the amount of gardening space available. While adding space to existing gardens may be a great idea to help more members of that garden's community get involved in that location, to truly serve the populations more community gardens are needed throughout the city. This statement also shows how the sub-code "Space" is important to the "Mobilizing Community Action" primary code. Even if better governance of the existing community gardens in Anchorage develops, the lack of community action to voice the need for more gardening space will preclude garden expansion.

In the next example it can be seen how the need for space will also require action from an organization's governing body as well.

"On a policy level there are areas of Anchorage that definitely need more access to locally grown fresh foods and community gardens can help with that. From our perspective anyone who wants to grow their own food should be able to. We should allow them the resources to do that."

This statement is very tricky in terms of coding as the respondent alluded to allowing people the resources to grow their own food. This could also mean infrastructural resources. But based on the overall context of the respondent's answer, it was deemed that the focus here was on giving people the space to grow their own food. Giving people more access to locally grown food would start with increasing the production of locally grown foods, and as the respondent states, community gardens could help with that. The primary need then becomes gardening space. It can be seen that all other aspects, such as management, organization, and infrastructure, are important factors to this respondent's overall vision of the resources needed for better access to locally grown produce to come to fruition. However, without increases in gardening space, increased production cannot take place.

The "Infrastructure" sub-code touched on an important aspect of "Community Action" because infrastructural needs are often illustrated through community utilization of space and community interest in expanding its infrastructure. In the following response, infrastructure is directly related to community interest.

> "If you give me 100,000 dollars we could have ten more community gardens built before the end of the summer. So that is an easy thing to point to, but cash is just an indicator that people are interested or care."

In this response, the creation of garden space is coded as "Infrastructure" because the creation of more space is not referring to the need for more garden space but rather in how more gardens and the infrastructure surrounding them could be built if community interest is present.

> "[We] have 100 parks and only two gardens right. So you can kind of just do the math to see where the attention is going to be. And because of that I just don't think you have a very robust infrastructure put on gardens."

Much like in the previous example, this example indicates how infrastructure is an indication of community interest, and also suggests community action is necessary for urban gardeners, community gardeners, and those hoping to move towards urban gardening to have a representative voice.

The responses gathered through the interview process indicate that there is a great importance placed on improving governance. This should not come as a surprise, as improving governance also makes having an impact on improving community action for feasible. Improving governance and stimulating community action serves somewhat as a positive feedback loop, and within each primary code the sub-codes also serve very cyclical purposes. While management was referenced most often with regard to improving governance, organization took precedence as it is the key component to then being able to improve individual garden management.

3.4 Understanding Urban Soils Guide

As first introduced in the Research Methods chapter, the content of the guide *Understanding Urban Soils* was a result of undertaking quantitative soil and plant analysis, the unexpected responses from the key informants, and direct guidance from Ms. Sprinkle. The guide highlights often touched on topics regarding gardening in urban soils such as: the most common contaminants, identifying possible sources of contamination, creating a sampling strategy, and finding a lab for soil testing, and health impacts, but also introduces some topics that are rare among the other soil contamination guides researched for the study. These less common topics include researching land use history, interpreting results, and providing a metric for comparing soil testing results. The guide covers a variety of material, but is presented in a very neatly contained 18 pages of information. What the final result provides is a guide that contains information that many other references on gardening and soil contamination present, but goes a step further by exploring some of the issues gardeners may run into while trying to better understand soil contamination in urban gardens.

The findings of this project have resulted in a guide that was completely informed by the practicum experience (i.e., creating a soils sampling strategy, preparing samples for lab analysis, organizing results from a lab analysis, and researching land use history). This was crucial in creating a guide that has been set up to be as user-friendly as possible and highlights information that is most pertinent to understanding urban gardening soils (i.e., when and why they should be tested; how to research if a garden should be tested; how to take samples; and how to interpret lab results).

Chapter 4: Discussion and Recommendations

4.1 Urban and Community Gardening in Anchorage

It is important to note that this project was not designed to suggest that urban and community gardening in Anchorage and statewide is a means in and of itself to solve food insecurity. Nor was the research into soil contamination levels at the "C" Street Gardens meant to provide statistically complete and reliable data on the urban gardening soils in Anchorage. Rather, this project's research was undertaken as a means to highlight one area of need for Alaska's urban gardeners and create a guide that would help in addressing this need. *Understanding Urban Soils: A Guide for Better Understanding the Need and Practice of Testing for Garden Soil Contaminants* addresses the need for assistance in understanding soil testing and analysis, and focuses on providing concise and plain language for gardeners. It is recommended that urban gardeners in Alaska consult the UAF Cooperative Extension to address many gardening concerns, but research for the project indicates a need for more substantial soil contamination resources.

Also unearthed through this research was a collective voice from urban gardening organizers regarding organization and promotion of urban gardening in Alaska, specifically Anchorage. It is clear that there is much left to do for Alaska's community gardeners, and establishing a single organization that can help the various gardening communities pool their collective interest into a more cohesive effort would provide the structure and community unity to power a thriving urban gardening community in Anchorage and throughout Alaska.

It is clear from the key informant interviews that some of the existing organizations already share very similar views on the shortfalls of the current infrastructure, availability, and management of the community gardens in Anchorage. The information gathered from the key informant interviews points toward establishing a course of action for moving forward and creating better garden management, improved garden infrastructure and availability, community representation, and education.

Results from this modest study suggest that improving governance is the most pertinent task to improving Anchorage's and Alaska's urban and community gardening, starting at the organizational level, followed by more individualized management of each gardening space. For community gardening to take root in Anchorage as the key informants envision, they believe there must be a collective effort to design an organization that can tie all of Anchorage's various community garden outlets together. This will be key in city gardens being able to represent their cause in a unified and proactive manner. A unified organizational structure could serve as the best chance for future gardening development and infrastructure upgrades, along with providing a framework that can help the various communities manage their gardens in a manner befitting each unique location. These recommendations are easier said than done, and the scope of the project herein was not designed to provide significant insight into how this could be achieved, but what has been emphasized is that there is an awareness of the lacking continuity and representation of community gardening in Anchorage and an aspiration to set up a system that allows more people access to growing their own food. Program evaluations for the various organizations involved in promoting and organizing current gardening programs and expansion throughout Anchorage could be a great preliminary step to establish how current efforts, procedures, and cross-organization efforts could be improved to increase the collective effect each organization has on helping to further establish Anchorage's urban gardening community.

4.2 Urban Garden Soil Contamination in Anchorage

Lab results from the analysis of the C Street Gardens samples indicate safe levels for all the recoverable elements listed in EPA Method 200.8. In Table 7, soil contamination data from the C Street Gardens is presented with Human Health Screening Levels (HHSLs) and

Total Threshold Limit Concentrations of Hazardous Toxic Waste (TTLCHTW). Human Health Screening Levels are from the California Office of Environmental Health Hazard Assessment and represent “Below levels of concern for human health” (BLC) concentrations which indicate soil contamination levels that are below the threshold of causing a human health concern (2007). Total Threshold Limit Concentrations of Hazardous Toxic Waste (TTLCHTW) from the California Department of Toxic Substance Control represent “soil above this level may be unsafe” (Unsafe) concentrations (2010). A Total Threshold Limit Concentration analysis determines the concentration of an analyte in a sample. When the contaminant exceeds TTLC limits is classified as hazardous under the California state regulations (Sierra Analytical Labs, Inc, 2010).

Table 7

Soil ICPMS Results /Screening Levels

Sample	Sample 4	Sample 4D	Sample 5	Sample 12	Sample 13	BLC	Unsafe
Unit	mg kg-1	mg kg-1	mg kg-1	mg kg-1	mg kg-1	mg kg-1	mg kg-1
Analyte							
Arsenic	6.76	6.84	6.51	4.52	5.13	0.07	500
Barium	103	101	92.7	109	103	5,200	10,000
Cadmium	0.119	0.122	0.105	0.199	0.208	1.70	100
Chromium	20.38	20.5	20.5	23.7	21. 9	100,000	2,500
Lead	8.60	8.21	7.51	20.9	18.54	80.0	1,000

With the exception of the BLC for arsenic, none of the samples tested contained contaminant concentrations approaching unsafe levels. The results did suggest, contrary to expectations, that lead concentrations increase with distance from busy C Street and 19th Avenue. However, due to the constraints of this study, results here cannot draw conclusive determinations regarding soil contamination patterns in the city of Anchorage.

Future exploration of urban gardening soils in Anchorage could be informed by the consideration of the United States Department of Transportation's classification of roadways:

- Local roads (Low Traffic): service the residents of a specific neighborhood.
- Collector Roads (Low to Moderate Traffic): connect local roads to Arterial roads
- Minor Arterial (Moderate Traffic): Smaller arterial roads that serve smaller neighborhoods or principle arterial roads.
- Principle Arterial (Moderate to High Traffic): gather traffic from all local, collector and smaller arterial roads to move them to highway/freeway roads.
- Highway (High Traffic): span cities and connect cities to cities (U.S. Department of Transportation, 2013).

These standards are touched upon in *Understanding Urban Soils*, and are an interesting set of roadway categories that should be further researched in Alaska communities in an effort to prioritize soil sampling schemes and the interpretation of results. Anchorage's urban sprawl is an interesting development where the categories the U.S. Department of Transportation has established may not always mesh well with how motor ways actually produce traffic scenarios in Anchorage.

Fairbanks, Alaska's next largest city, has been known to have considerably lower air quality than Anchorage. Air quality alone would not indicate higher soil contamination levels, but it is feasible that this poorer air quality would cause differences in the soil concentration levels experienced in Anchorage and Fairbanks. Weather differences between the two cities can again be expected to play a part in differences between soil contamination levels between the two; especially with respect to how weather influences soil organic matter decomposition, soil microbial communities, hydrology, and the burning of fuels. Weather differences, population variances, differences in each town's current and historical development, and differences in the daily way of life in communities across Alaska further make generalizing any findings in one town to another difficult.

The C Street Gardens should also have further testing done on its soils. Of the four soil samples tested in the lab, there was a distinct difference between Sample 4 and Sample 5, which were closer to C Street and also had lower concentrations of lead than Sample 12 and Sample 13. Because the sample size of this study only represents a small portion of the garden, a larger-scale soil testing study would be beneficial to a deeper understating of the whole garden's soil contamination levels. It is recommended that the soil from each individual plot be sampled and tested as to give a plot-by-plot analysis of contamination levels across the different areas of the entire garden. Looking into the surface water flow and topography of the gardens should also be considered. This information could be beneficial to determining the cause of the elevated levels of contaminants in certain plots over others and help in furthering policy and procedures for identifying and preparing gardening space. Soil testing done at the other community garden locations is also recommended for furthering the efforts of creating a general soil contamination profile for Anchorage. This could also be an exercise that lends itself to greater networking between local gardening communities.

It could be argued that the most important aspect to this discussion is the complexity of understanding soil contamination and how this complex science can be presented to the gardening community in a more accessible language and format. This issue was the main focal point of *Understanding Urban Soils*, and there is a substantial amount of progress to be made on presenting a complex science to a general public. The most important aspect to relaying this information may be a universal standard of safe levels of contamination for gardening soils. This could be the simplest solution to the complexity of the issue of soil testing as gardeners and community garden organizers could then simply collect soil samples, have them tested at testing laboratories, and then compare results to the given standard. This removes the need for understanding soil contamination beyond sampling strategies and the comparison of test results to an established standard for human health practices. As it stands now, anyone looking to understand their soil analysis results must rely on results compared to multiple and varying standards typically concerned with land development rather than agriculture.

How the task of creating a homogenized standard of soil contamination for gardening is carried out is debatable. In Alaska, it seems worthwhile to draw on the collective strengths of the entities currently working on expanding gardening in Anchorage to use their collective knowledge to set a standard. If this recommendation was to take place, it could kick start the process in other communities and even states that could then further catalyze the creation of regional or national standards.

4.3 Understanding Urban Soils Guide Discussion

The *Understanding Urban Soils* guide represents a concept model of presenting information about soil contamination to gardeners in a concise and comprehensive manner. The concept of taking information that is scientifically intricate and making it more easily understandable is a goal the guide tried to adhere to. Currently, a multitude of studies on gardening in contaminated soils have presented an overwhelming amount of data that, up to this point, has not been translated into terms that a lay person could make use of. To compound matters, there exists an overwhelming amount of soil contamination recommendations that do not always come to consensus of what levels are safe. Many recommendations use asymmetrical terminology. Some agencies report as “below levels of concern” while another may present “safe” levels of contamination, while still another presents “unsafe levels”. Use of differing units of measure and differences in the intended use for the information all continue to compound the casual and even dedicated gardener looking for some clarity on gardening in contaminated soils.

While *Understanding Urban Soils* does not remedy all of these issues it does bring together a digestible amount of this information into one source and presents it as clearly as possible. It is also important to keep in mind who the information is being presented to. The information has to be understood and useful to gardeners. For future development of urban gardening, it is important to keep the rational choice model and the context model in mind. The rational choice model asks, “What do people want to know in order to be good citizens - even to survive - in a culture largely shaped by science?” (Weigold, 2001). Without good and clear scientific knowledge of the subject, people might not make their choices optimally (Weigold, 2001). While it is recommended that both models be researched, the context model may be even more crucial to study. The context model asks, “What do people want to know in their particular circumstance?” (Weigold, 2001). What are urban gardeners concerned about and how do they want to be informed about it? If the goal is to help gardeners understand and better protect themselves from risk, then the information needs to be practical and not require hours of supplementary research. This latter activity distracts from the gardening and ultimately probably leaves many gardeners forgoing the attempt to educate themselves on the issue of urban soils. But, what if most gardeners aren’t concerned with soil contamination at all? This perhaps even rearranges the issue from how is scientific knowledge translated into a mainstream and understandable language to how should the potential risks be framed so as to communicate that their might be a health problem? Researching what soil contamination information is useful to gardeners and connecting this information to already established gardening principles, such as soil nutrient testing and management, seems it could be a highly successful way of bringing new information into the average gardeners consciousness and keeping it there. However, it is possible that more research needs to be undertaken to better understand all aspects of the scientific communication of soil contamination as it relates to gardeners.

Dissemination of the guide will be crucial to its success. Seeking advice from expert sources within the gardening community such as the Foraker Group, ACAT, and the UAF Cooperative Extension should be undertaken to make sure that *Understanding Urban Soils* is made available through the most productive venues.

4.4 Alaska's Place in the Global Food System

Recalling the WHO definition of food security as "when all people in a given population have at all times sufficient, safe, and nutritious food to maintain healthy lives", the circumpolar north occupies a unique place in the global food system (WHO, 2012). It is important to note two distinctions made by Fresco (2009) relating to food security; the first being that food system vulnerability is not limited to developing countries, and the second being that, in the end, food security is the responsibility of the state. This puts Alaska in particular in a very precarious situation when it comes to the how the state is incorporated into the global food system. Alaska, much like the rest of the United States, relies heavily on produce shipped and imported from all over the world to large commercial grocers, as well as to smaller retailers in rural Alaska. Alaska is susceptible to all the same vulnerabilities to the global food system that the rest of the United States is, but is also subject to the higher cost of transport of these foods and the very real possibility that the transport of food can be interrupted for an indefinite amount of time. Because Alaska exports a relatively marginal amount of food, there is little Alaska grown food to utilize during a lengthy interruption in the imported food supply. Natural disasters such as earthquakes and tsunamis could leave Alaska cut off from the rest of the world as harbors, airstrips and the state's lone interstate highway are destroyed or left incapacitated. Even though this scenario is unlikely to result in the total disconnection of Alaska from the outside world, damage could still be severe enough to strain resources such that the pressure on Alaska's food system could result in food shortages and significant increases in cost. When considering Alaska's place in the global food system, it seems paramount that Alaska focus on self-sufficiency. It is highly unlikely that urban gardening in Alaska will play a major role in alleviating this burden, but how the state operates within the global food system is an important issue, and ways to make food more readily and dependably available throughout the state needs to be researched and maximized. It is conceivable that community gardening and urban agriculture could help in researching food security factors indicating if households get enough food, what and how that food is distributed, and what and how household foods fulfill nutritional needs.

The importance of urban gardening in Alaska may be important to improving Alaska's place in the global food system, not necessarily by providing a substantial contribution to Alaska's food resources, but rather by generating and raising awareness and involvement by the public in how their region fits into a global food system. With climate change altering the world's agricultural landscape, regionalized food systems could serve a much more prominent role in how various communities get their food in the future. Further, promoting a universal and easily understood standard of soil contamination and human health is a step that could be taken to help the public establish a greater awareness and responsibility for the food they consume.

Nevertheless, it should not be considered a stretch to think that urban gardening could play a prominent role in how Alaskans get their food in the future and in designing better practices for producing food. As more people join organizations promoting gardening and sustainable agriculture, the collective voice of the public having more control over the food it consumes and how that food is produced becomes much more realistic as these organizations would undoubtedly become resources for creating sustainable agricultural practices that are very likely to be needed for future food security. Alaska especially should focus on its place in the global food system and consider a stricter shift toward a regional food supply system. Nutrition is a predominant factor of human health and this is a time where the general public has less and less say in how food is grown, shipped, and handled. It seems counterintuitive in the promotion of public health for such an important aspect of human health to be so marginalized. One of the more promising outcomes that could come from the promotion of urban agriculture is a shift toward more consumer-oriented food procedures, where the general public can have more of an awareness and voice about how the food that ends up in their grocery stores, restaurants, and plates is produced and is regulated.

Chapter 5: Project Outcomes, Strengths, and Weaknesses

The great strength of this project was the production of *Understanding Urban Soils*, which was informed by the key informant interviews, literature review, and the soils and plant tissue sampling, lab preparations, and analyses.

There are numerous aspects of the guide that make it a useful product. The guide was originally intended to help urban and community growers improve their gardening skills. It is fortunate that this changed as much as it did, as much of that information is already available through the UAF Cooperative Extension Service. It is true that *Understanding Urban Soils* does reintroduce information put forth by many other publications and organizations, but it has a more reader-friendly approach that brings together multiple topics on the issue of urban soil contamination and presents them in an easy, concise, and user-friendly manner. While the guide is somewhat specific to Alaska, it also tackles topics that could easily be generalized to other urban areas.

A key strength of the guide is its presentation of land use history. The guide addresses how gardeners might find information on past land use in a practical way, by providing users an individualized course of action that starts small (speaking to neighbors) and moves to broader, but still individualized, information resources (e.g., local historical societies, the Bureau of Land Management, or the local court house).

Understanding the units of measure for soil contamination is another aspect that the guide addresses. Soils science, as it relates to soil contamination, is a complex area of study and most gardeners are probably most concerned with whether the soil is safe for gardening, and, if it is not, what steps can be taking to reduce exposure. Providing gardeners with an easy to understand units of measure conversion table to then compare to soil test results is meant to foster easy interpretation of soils data.

The original goal of the project was to obtain information from Anchorage community gardeners themselves, but this plan was ultimately abandoned due to low participant turnout and unresolvable language and cultural barriers. The survey format was thus changed to that of an interview and the gardeners were substituted by key what may help community gardeners be more successful beyond better gardening practices, tips and tricks. Those are perhaps secondary to the success of community gardens; what is most important is that urban gardeners have adequate support and voice with respect to garden management and community action.

References

Alaska Daily News (2009, October 14). Anchorage in US top 10 for community gardens. Alaska Daily News, http://www.adn.com/2009/10/14/973601/anchorage-in-us-top-10-for-community.html

Agency for Toxic Substances and Disease Registry (ATSDR). (2003a). Toxicological Profile for Benzene. U.S Department of Health and Human Services Public Health Service. Retrieved in April 2012 from http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=14

ATSDR (2003b). Toxicological Profile for Lead. U.S Department of Health and Human Services Public Health Service. Retrieved in April 2012 from http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=22

ATSDR (2003c). Toxicological Profile for Toluenene. U.S Department of Health and Human Services Public Health Service. Retrieved in April 2012 from http://www.atsdr.cdc.gov/toxprofiles/tp.asp?id=161&tid=29

Brown, K. H., & Jameton, A. L. (2000). Public health implications of urban agriculture. *Journal of Public Health Policy*, 20-39.

Broyles, A. (2012). Urban ag coordinator gains ground in Austin. City Farmer News. Retrieved on April 7, 2012 from http://www.cityfarmer.info/2012/04/04/urban-ag-coordinator-gains-ground-in-austin/

Bryman, A. (2008). Social Research Methods. 3rd ed. Oxford University Press. Oxford, New York.

Bubela, T., Nisbet, M. C., Borchelt, R., Brunger, F., Critchley, C., Einsiedel, E., . . . Caulfield, T. (2009). Science communication reconsidered. *Nature Biotechnology*, 27(6), 514-518. doi:10.1038/nbt0609-514

Buczynska, A. J., Krata, A., Stranger, M., Locateli Godoi, A. F., Kontozova-Deutsch, V., Bencs, L., . . . Van Grieken, R. (2009). Atmospheric BTEX-concentrations in an area with intensive street traffic. *Atmospheric Environment, 43*(2), 311-318. doi:10.1016/j.atmosenv.2008.09.071

Clark, H. F., Hausladen, D. M., & Brabander, D. J. (2008). Urban gardens: Lead exposure, recontamination mechanisms, and implications for remediation design. *Environmental Research, 107*(3), 312-319. doi:10.1016/j.envres.2008.03.003

Cruz, Y. (2010). Community gardens have a positive effect on people and neighborhoods. *El Nuevo Sol*. Retrieved on February 25, 2012 from http://www.elnuevosol.net/destacados/the-growth-of-community-gardens

Durmusoglu, E., Taspinar, F., & Karademir, A. (2010). Health risk assessment of BTEX emissions in the landfill environment. *Journal of Hazardous Materials, 176*(1-3), 870-877. doi:10.1016/j.jhazmat.2009.11.117

Environmental Protection Agency. 1996. “Method 3050B: Acid Digestion of Sediments, Sludges, and Soils,” Revision 2.

Ericksen, P. J., Ingram, J. S., & Liverman, D. M. (2009). Food security and global environmental change: emerging challenges. *Environmental Science & Policy*, 12(4), 373-377.

Fresco, L. O. (2009). Challenges for food system adaptation today and tomorrow. *Environmental Science & Policy*, *12*(4), 378-385.

Hancock, T. (1985). The mandala of health: a model of the human ecosystem. *Family & Community Health*, *8*(3), 1-10.

Hancock, T. (2001). People, partnerships and human progress: building community capital. *Health Promotion International*, 16(3), 275-280.

Heinegg, A. Margos, P., Mason, E., Rabinowicz, J., Straccini, G., & Walsh, H. (2000). Soil contamination and urban agriculture: A practical guide to soil contamination issues for individuals and groups. Quebec, Canada: McGill University, McGill School of Environment. Retrieved on February 20, 2012 from http://www.ruaf.org/node/1003

Hazardous Substance Data Bank (HSDB). (2012). National Library of Medicine TOXNET. Retrieved in April 29, 2012 from http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~6UQHZM:1

Consulting Group, Inc. (1999). Garden vegetable sampling at residences for determination Of risk-based exposure to metals. Environmental Protection Agency. Retrieved on June 2, 2012 from http://www.epa.gov/region8/r8risk/sampling.html

Lah, K. (2011). History of Lead Use. Toxipedia. Retrieved April 7, 2012 from http://toxipedia.org/display/toxipedia/History+of+Lead+Use

Leake, J. R., Adam-Bradford, A., & Rigby, J. E. (2009). Health benefits of 'grow your own' food in urban areas: implications for contaminated land risk assessment and risk management.*Environmental Health: A Global Access Science Source*, 81-6. doi:10.1186/1476-069X-8-S1-S6

Loring, P. A., & Gerlach, S. C. (2009). Food, culture, and human health in Alaska: An integrative health approach to food security. *Environmental Science & Policy, 12*(4), 466-478. doi:10.1016/j.envsci.2008.10.006

Kattides, M. L. M., & Lima, M. G. B. (2008). Changing food systems and implications for sustainable communities: Cyprus, Canada, and Brazil. *Environments*, 36, 1.

Kwik, J. (2008). Traditional food knowledge: a case study of an immigrant Canadian “foodscape". *Environments*, *36*(1), 59.

Mason, B. (1992). *Preparation of Soil Sampling Protocols: Sampling Techniques and Strategies*. EPA/600/R-92/128. Environmental Research Center University of Nevada-Las Vegas Retrieved on May 17, 2012 from http://www.epa.gov/oust/cat/mason.pdf

McBride, M.B. (2010). Reducing Exposures to Soil Contaminants from Urban Gardening. NIEHS
Grant: R21ES017921. Retrieved February 5, 2012 from http://wwwniehss.nih.gov/research/supported/programs/peph/prog/rta/mcbride/index.cfm.

McKelvey, B. (2009). Community Garden Toolkit, University of Missouri Extension. BulletinPM906. Retrieved on Feb 29" 2012 from http://extension.missouri.edu/p/MP906

Municipality of Anchorage (N.D.). Parks and Recreation: Community Gardens. Municipality of Anchorage. Retrieved on February 25, 2012, from http://www.muni.org/Departments/parks/Pages/GardenPlots.aspx

Nabulo, G., Young, S.D., & Black C.R. (2010). Assessing risk to human health from tropical leafy vegetables grown on contaminated urban soils. *Science of the Total Environment*.408, (22): 5338-5351. Retrieved on February 20, 2012 from http://www.sciencedirect.com.proxy.consortiumlibrary.org/science/article/pii/S004896971000639X

National Research Center, Inc. (2006). Community Food Project Evaluation Toolkit 3rd ed. *Community Food Security Coalition*.

Newman, L. (2008). Extreme local food: Two case studies in assisted urban small plot intensive agriculture. *Environments*, *36*(1), 33.

Newman, L., & Ostry, A. (2008). From seed to table: the challenge of creating sustainable food systems. *Environments*, *36*(1), 1-5.

Ohmer, M. L., Meadowcroft, P., & Freed, K. Lewis. E.(2009). Community gardening and community development: Individual, social and community benefits of a community conservation program. *Journal of Community Practice*, *17*(4), 377-399.

Oliva, R., Fernandez Espinosa, A.J. (2007). Monitoring of heavy metals in topsoils, atmospheric particles and plant leaves to identify possible contamination sources. *Microchemical Journal*. Vol. 86, Issue 1, PP 131-139. Retrieved on February 20, 2012 from http://www.sciencedirect.com.proxy.consortiumlibrary.org/science/article/pii/S0026265X07000045

Schukoske, J. (2000). Community development through
gardening: State and local policiesTransforming Urban Open Space. *American Community Gardening Association*. Retrieved on February 29, 2012 from http://communitygarden.org/docs/learn/schukoske.pdf

Sierra Analytical Labs, Inc. (2010). Retrieved from https://www.dtsc.ca.gov/LawsRegsPolicies/upload/Sierra-Analytical-Labs-Report.pdf

Smeenk, J., Nakazawa, A., & Martin, S. (2011). Community gardens in Alaska. University of Alaska Fairbanks. Retrieved February 29, 2012 from http://www.uaf.edu/files/ces/publications-db/catalog/anr/HGA-00029.pdf

Standard Operating Procedure Six. (2003). Quality control assurance/quality control samples. Retrieved from http://denr.sd.gov/des/gw/spills/handbook/sop6.pdf

Stirling, D. (2000). Using Land History to Identify Public Health Risks. *Clinical Medicine & Health Research.* Netprints, clinmed/2000080009v1. Retrieved on April 20, 2012 from http://clinmed.netprints.org/cgi/content/full/2000080009v1

Truc, V. T. Q., & Kim Oanh, N. T. (2007). Roadside BTEX and other gaseous air pollutants in relation to emission sources. *Atmospheric Environment, 41*(36), 7685-7697. doi:10.1016/j.atmosenv.2007.06.003

Utermohle, C., Wells, R., & Fenaughty, A. (2008). Food insecurity in Alaska: Public health implications of food insecurity. Alaska Department of Health and Social Services. Retrieved on February 29, 2012 from http://www.hss.state.ak.us/dph/chronic/hsl/brfss/pubs/Food-Insecurity.pdf

U.S. Department of Transportation. Federal Highway Administration. (2013). Retrieved from http://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/section03.cfm

Uzu, G., Sobanska, S., Sarret, G., Munoz, M., & Dumat, C. (2010). Foliar lead uptake by lettuce exposed to atmospheric fallouts. *Environmental Science & Technology, 44*(3), 1036-1042. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=48274015&site=ehost-live

Verburg, P. H., Mertz, O., Erb, K. H., Haberl, H., & Wu, W. (2013). Land system change and food security: towards multi-scale land system solutions. *Current Opinion in Environmental Sustainability, 5*(5), 494-502.

Vrscaj, B., Poggio, L. & Ajmone Marsan, F. (2008). A method for soil environmental quality evaluation for management and planning in urban soils. *Landscape and Urban Planning*. Vol. 88, Issues 2-4, PP 81-94. Retrieved on February 20, 2012 from http://www.sciencedirect.com.proxy.consortiumlibrary.org/science/article/pii/S0169204608001333

Wakeman, J. (2012). Which 10 Cities Have the Most Urban Gardens? The Daily Green. Retrieved on February 25, 2012 from http://www.thedailygreen.com/green-homes/latest/community-gardens-091509

Wakefield, S., Yeudall, F., Taron, C., Reynolds, J., & Skinner, A. (2007). Growing urban health: community gardening in South-East Toronto. *Health Promotion International, 22*(2), 92-101.

Wegner, W., & Yaggi, M. (2001). Environmental impacts of road Salt and alternatives in the New York City watershed. *The Journal for Surface Water Quality Professionals*. May/June 2001 Issue. Retrieved April 7, 2012 from http://www.newyorkwater.org/downloadedArticles/ENVIRONMENTANIMPACT.cfm - soils

Weigold, M. F. (2001). Communicating science: A review of the literature. *Science Communication*, *23*(2), 164. Retrieved from http://proxy.consortiumlibrary.org/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=aph&AN=5712565&site=ehost-live

World Health Organization (WHO). (2012). Food Security. Trade, foreign policy, diplomacy and health. Retrived on June 4, 2012 from http://www.who.int/trade/glossary/story028/en/

Wu, W., Tang, H., Yang, P., You, L., Zhou, Q., Chen, Z., & Shibasaki, R. (2011). Scenario-based assessment of future food security. *Journal of Geographical Sciences, 21*(1), 3-17.

Appendix A

Community Gardening Interview

CONSENT FORM

PRINCIPAL INVESTIGATOR:

Ryan McWilliams
Graduate Student, Master of Public Health Program
University of Alaska Anchorage
(907) 330-9794
rbmcwilliams@uaa.alaska.edu

Research Advisor

Dr. Elizabeth Hodges-Snyder
Assistant Professor of Public Health
University of Alaska Anchorage
(907)-786-6541
afeh1@uaa.alaska.edu

DESCRIPTION:

I am interested in how participating in community gardening can influence lives and in the procedures and practices that should be followed in the gardens (from planting to eating the produce grown). Information you share with me will be used to inform the creation of a community garden practice guide to help promote the health benefits of community gardening.

VOLUNTARY NATURE OF PARTICIPATION:

Your participation in this study is voluntary. If you don't wish to participate, or would like to end your participation in this study simply state so. In other words, you are free to make your own choice about being in this study or not, and may quit at any time without penalty.

Expected Duration:

The expected time needed to conduct this interview will vary amongst interviewees.

BENEFITS:

There will be no direct benefit to you from participating in this study. The results of this study may benefit Alaskan community gardeners in the future.

RISKS:

There are no risks in participating in this survey.

CONTACT PEOPLE:

If you have any questions about this research, please contact the Principal Investigator at the phone number listed above. If you have any questions about your rights as a research subject, please contact Sharilyn Mumaw, Compliance Officer, at (907) 786-1099.

SIGNATURE:

Your signature on this consent form indicates that you fully understand the above study, what is being asked of you in this study, and that you are signing this voluntarily. <u>If you have any questions about this study, please feel free to ask them now or at any time throughout the study.</u>

Signature ___________________________________ Date __________________

Printed Name ____________________________

A copy of this consent form is available for you to keep.

Appendix B
Key Informant Questions

1. What are some common inefficient gardening practices you see used in the community gardens that you are familiar with that may be detrimental to:

Community gardeners experiences….
Yield……
Gardening work load….
Health…..
or..

2. In my short time researching community gardens I have noticed the varying degree of success between community gardens in Anchorage?

3. What are some reasons you can give for these differences and what do you think is the best way of spreading this success from one garden to another?

4. What are some things that are perceived as requirements for gardening that may hold gardeners back from participating that are not truly needed in order to garden. What are some things that you have noticed at gardens here that are still needed?

5. What advice would you like to give to gardeners new to the state of Alaska? What advice would you like to give to the more veteran gardeners to improve their gardening?

6. What information do you think should go into the guide pertaining to improving community garden participation, cooperation, and organization? (In terms of generating participant organized initiatives)

7. Are there any other ideas or comments of your own you would like to add?

8. After looking at the gardening survey, what are some areas you think could be improved or questions you think should be added/omitted?

Appendix C
Understanding Urban Soils (text-only form of the guide)

Introduction:

This Urban Gardening Guide provides Alaska's Urban gardeners with some general urban gardening information concerning soil contamination along with information on tackling soil contamination in Alaska.

This guide has been put together in conjuncture with Alaska Community Action on Toxics as part of a Master of Public Health project concerning urban gardening in Alaska.

This Guide will provide gardeners with:

- Information on the most common contaminants found in urban soils.
- Information on identifying possible sources of contamination.
- Creating a soil sampling strategy for contamination testing.
- Understanding the results of a soil tests.

This guide was created to help urban gardeners implement effective strategies to limit exposure to urban soil contaminants they may encounter to through gardening. There is no true guideline to what is considered safe when it comes to gardening in contaminated soils. But the common sentiment among health and gardening organizations is that limiting exposure is in the best interest of those gardening in urban soils. Soil contamination in urban areas is well documented but gardeners can effectively limit exposure to these contaminants in a variety of ways. Gardening has been shown to host a number of health benefits from physical and mental health to improved nutrition (CITE). Urban gardening has shown the same health benefits and is a practice that should be encouraged and expanded. This guide aims to help gardeners understand soil testing and reduce exposure to soil contaminants further improving the health benefits gardening provides to health.

Alaska Community Action on Toxics:

ACAT is a statewide environmental health and justice organization based in Anchorage Alaska. ACAT has successfully advance local, state, and international actions to protect people from harmful chemical exposure and to safeguard our air, water, and food since it was established in 1997. ACAT's mission is to assure justice by advocating for environmental and community health. ACAT believes that everyone has the right to clean air, clean water, and toxic-free food. One of the multiple ways ACAT helps is by implementing effective strategies to limit their exposure to toxic substances and to protect and restore the ecosystem that sustain them and their way of life. ACAT has also worked to promote safer alternatives for home and garden including holding workshops on green cleaning and organic gardening, maintaining an organic garden at the C Street Community Garden in Anchorage, and promote organic/non-toxic gardening methods.

Urban Soils and Contamination

Urban areas are dynamic environments with a large gamut of anthropogenic activity. Industrial activity, out dated or band household practices (Such as the use of lead paint), the improper storage of old vehicles and their petroleum products, along with many other commonly experienced urban practices can have an impact on the level of contamination found in soils throughout towns and cities. Though some sights may have contamination present than others it is a safe bet that if you have an urban garden or are planning on starting one that the soil at that location is contaminated. The possibility of soil contamination should not however keep gardeners from gardening. Instead inform yourself about the non-existence or presents of contamination in your garden's soils, the source from which it came or could come from, and how to manage and garden accordingly.

Sources of Contaminants in Soils:

Location of a gardening plot and the contamination it may contain can be affected by the garden's proximity to roadways, industrial areas, water runoff, and junk vehicles. Fertilizer and pesticide use, furniture refinishing, treated lumber, previous fires, and especially the land's past history all indicated what kind of contaminants could be present. In the table below some of the more common contaminant sources and examples of their use are listed along with the contaminants they contain.

General Source	**Example of Use**	**Specific Contaminant**
Paint (before 1978)	Old residential buildings; mining; leather tannin; landfill operations	Lead
High Traffic Areas*	Roads serving more than just your local community. Take extra precaution with roads built before lead fuel was phased out. (1986)	Lead, Zinc, PAHs
Treated Woods	Lumber treatment facilities; treated woods used for residential building	Arsenic, Chromium, Copper
Burning Waste	Landfill operations; private waste removal practices	PAHs, Dioxins

Coal Ash	Coal-fired power plants; land fills	Molybdenum, Sulfur,
Sewage Sludge	Sewage treatment plants; agriculture	Cadmium, Copper, Zinc,, Lead, PBTs
Petroleum Spills	Gas stations; residential/commercial/industrial uses (anywhere an above ground or underground storage tank is or has been located)	PAHs, Benzene, Toluene, Xylene
Commercial/Industrial Site Use		PAHs, Petroleum Products, Solvents, Lead, Other Heavy Metals
Pesticides	Commercial or residential agriculture use of pesticides	Lead, Arsenic, Chlordane, and other Chlorinated Pesticides

*****A quick break down of understanding traffic areas around your home and neighborhood. The United States Department of Transportation classifies road ways in the following categories

- Local roads (Low Traffic): Service the residents of a specific neighborhood.
- Collector Roads (Low to Moderate Traffic): Connect local roads to Arterial roads
- Minor Arterial (Moderate Traffic): smaller arterial roads that serve smaller neighborhoods or principle arterial roads
- Principle Arterial (Moderate to high traffic): gathers traffic from all local, collector and smaller arterial roads to move them to highway/freeway roads.
- Highway (High traffic): Span cities and connect cities to cities.

It is recommended that if you live in an area close to or on arterial roadways you consider yourself in a high traffic area.

Land Use History:

Looking into the past history of the land your garden occupies is a great way to determine what type of contaminants to test for. But before warned land use history research can be a very in depth study. Because certain types of land use are associated with specific contaminants it can tell you not only what types of contaminants may be present but also what types of contaminants are likely not to be found. Excluding contaminants that are not likely to be found form a soil test is a great way to limit the cost of testing.

Researching land use history is going to be different for nearly every neighborhood and every town/city. However there are some typically practices that should turn up information for anyone trying to do this type of research. Doing the following will typically help gather clues that will eventually add up to something substantial to help you with understanding your properties history.

- Start simple and close to home: Seek out people who have lived in the neighborhood for a long time. Long tenured neighbors can often give you insight into what the area was like before or during development. If they have not lived in the neighborhood long enough to have seen its development they still may know more of the neighborhood's history based off of sharing with their original neighbors. Local schools and churches can be great resources too. Both often keep records on their area's development. Finally, consider using a metal detector in your yard. You could unearth clues that could add to the story of your home.
- Check out the local Bureau of Land Management office and the local or county Court House: Anchorage and Fairbanks both have BLM offices that will house homestead files on subdivisions. A BLM office will also typically have a public research room. You can also research other municipal planning agencies to find leads. Try and locate a copy of your property's abstract. Property abstracts will record all the deeds or legal transactions associated with your property. A property abstract can also give you the names of previous owners, who can give you information on additions, improvements, and modifications done to the house among other useful items of information.
- Look into your town/cities property assessment and tax record: This too can give you information about the development of your neighborhood and the building of your home and neighborhood.
- Check out your local museum: Speak with research room staff to see if they have photos of the land before, during, and after development. They may have other interesting information about how your property came into existence.
- Find out your neighborhood developer's name: This is a great lead. If you can find out who the developing company was you should have one more direct source to your land use history. Survey maps can be located in other permitting and planning offices but the developers' office is a great to place to find these as well. Survey maps can give you a great picture of what has been added and demolished from the property.
- Ask for help from your local historical society: Start by going to www.alaskahistoricalcociety.org find your local chapter and contact them for information. Even if they cannot provide specific information to you about your neighborhood they will most likely be willing to help you with the research by pointing you in the right direction, getting you connected with people that can help, and advising you in how to proceed with your research.

Remember that cities and neighborhoods change so start your research backwards. You obviously know your properties current state so start with what is known and work backwards. Street names and addresses can change and if you are looking for information on an address, street, or neighborhoods that did not exist in the particular time frame you are researching in it may be hard to find that information based on present day names and numbers.

Health Risks:

It is important when thinking of urban soil contamination to keep things in perspective. Contaminants pose risks to our health but these risk are hardly ever sever through urban gardening. Gardener's should still protect themselves from these contaminants, as many are persistent, bio-accumulative, and harmful to our health and the health of our families. The knowledge on the risk these contaminants possess through the practice of urban gardening is relatively small. There is still exciting evidence that many of these contaminants do pose health risks and avoiding them is highly advisable for protecting health.

Below is a list of some of the health risk associated with the main contaminants found in urban soil.

- **Lead:** Nerve damage, increased blood pressure, hearing and vision impairment, anemia, liver and kidney damage, and developmental delays in children.
- **Arsenic:** Bladder, lung, and skin cancer, nervous system damage, pulmonary damage, reproductive problems, and birth defects.
- **Dioxins:** reproductive problems, immune system damage, hormonal interference, and carcinogenic.
- **PAHs:** Highly carcinogenic, pulmonary damage, gastrointestinal damage, and kidney damage.
- **Chlordane:** nervous system damage, digestive system damage, and liver damage.

Health Impacts:

Health impacts can be positive and negative. In urban gardening we encounter a large number of beneficial health impacts. Impacts such as improved nutrition, improved physical activity, some relief of monetary stress, and improved mental and social health are some of the positive health impacts we see. Gardening in contaminated soils rarely has a negative impact on these benefits, but the health risk associated with many contaminants can have a negative impact on health. Lead is an example of a contaminant that if present will not decrease the positive impacts that has already been mentioned. If lead is present in your garden you will still reap the benefits of eating nutritious food, being physically active in your garden, and bonding with family, but exposure to the lead in the soil for children and young family members can have a negative impact on their health. Children are a group that is at high risk for lead exposure and increasing their level of exposure through lead contaminated garden soil can negatively impact their health by being another source adding to lead exposure.

Soil Testing

There are two main types of soil test gardeners can have done on their gardening soil. The two are Soil Characteristics or Soil Quality testing and then there is Soil Contamination testing. Both can be very beneficial to the health of you and your garden.

Testing for soil characteristics such as soil mineralogy and clay content, pH, and organic matter is a great strategy for helping manage the mineral and nutritional properties of your soil to help your garden produce more effectively. This type of testing can provide information can actually be helpful in regards to soil contamination also. Soil pH and the amount of organic matter present can have a great effect on the fate of contamination present in the soil. The availability of plant nutrients can be greatly affected by soil pH. The close to neutral soil pH can be the better soil nutrient uptake is accomplished by the vegetation inhabiting the soil. Organic matter contributes to overall soil health in a great many ways, but plays an important role in moderating soil pH and also by binding to contaminants. The binding of organic matter to contaminants found in the soil keeps these contaminants out of the soil solution and hinders their uptake by the plants in the soil.

Testing for contamination will tell if contaminants exist in your soil and what their concentration are. This information will be beneficial in planning how to avoid exposure. This certainly is not the end point of soil contamination research but for the practical purposes of an urban garden this should be all that is needed to help reduce exposure and continue healthy gardening.

Deciding when to test:

Adhering to the precautionary principle is always advisable. This means you should limit behaviors that could lead to exposure even if you have not had a soil test done, but it also means that a soil test is still advisable even if an examination of your garden space and land use history do not indicate contamination. It is important to remember that urban environments have a multitude of contamination opportunities. It bears repeating that if you are gardening in an urban area many sources of contamination are unavoidable. There could be a contamination source that was over looked of one from the past land use history that was undocumented. The extent to which sources apply contamination to your soil is dependent of many variables, but studies show that most urban soils have elevated levels of one contaminant or another. It is up to all individuals to decide if the monetary expense of a soil test is worth the data it will provide, but if any of the main sources of urban soil contamination are currently present or are known to have been present at some point a soil test is strongly encourage. Keep in mind what your garden is being used for as well. If you are growing a few non-accumulating crops for you or your families private use skipping soil testing and practicing good exposure limiting behaviors may be just as well. But if your garden is extensive, you sale produce at local farmers markets, or the garden serves a community soil testing is highly advisable.

Crops most suitable for growing in contaminated soils:

There is much work to be done for Alaskans in terms of making this list more Alaskan specific. Many produce items that are staple else where do not do quite so well here with the shorter growing season and lower sun intensity. But here as some general agreed upon suitable and not as suitable items for growing in contaminated soils.

Suitable

- Tomatoes
- Eggplant
- Peppers
- Okra
- Squashes
- Cucumber
- Peas
- Beans
- Onions (bulbs)
- Alaskan's many berries (raspberry, blueberry, Salmonberries, and various others)

Not as Suitable

- Lettuce
- Spinach
- Chard
- Cabbage
- Kale
- Collards
- Broccoli
- Cauliflower
- Carrots
- Beats
- Potatoes
- Turnips

It is important to consider that there are many steps that can be taken to limit your exposure to contaminants found in soil and that the benefits of eating fresh produce should not be over looked when planning on what produce you intend to grow in your garden. Items are labeled "Not as Suitable" to imply that these produced are very rarely off limits for growing in contaminated garden soil but that they have been shown to uptake contaminants more readily than those in the suitable sections.

Strategies for testing:

Sampling is an important component to soil testing. One great aspect of soil sampling is that if you have done it before for soil quality testing, then you really already know how to collect the samples for contamination testing. Keep in mind that what sampling strategies and contaminant analysis you do depends on the issues your garden faces. It is important to plan ahead and understand what you want to know and why you want to know it. Think of question you want to know the answer too and what you will do once you have those answers. Is one section of the garden more susceptible to contamination? If contamination is present in one area will you sample other areas? Do children play and garden in the garden? How will I use this information to limit exposure? Knowing specifically why you want the test done is a major factor to consider in soil sampling. For instance if you have children that play in the garden you may be worried about direct soil ingestion form the garden. This usually occurs form topsoil so sampling the top two inches of the soil may be a good enough test for your purposes. Maybe you plant multiple root crops in your garden. If so testing deeper is probably a better sampling strategy for you. If you suspect on area may be contaminated maybe you will choose just to sample that area and depending on the results test other areas in the future. Some may choose to treat the entire garden as contaminated if any area sampled shows signs of contamination.

Here are some key steps to follow when soil testing.

- **Identify your questions and concerns regarding your gardening space:** Look at your gardening space. Determine if there are any potential sources of contamination present. Consider where your garden is located in regards to what area of the city you live in, where your house is situated in the neighborhood, where your garden is situated in on you property, and where other objects on your property are situated in regards to your garden. Think about what forms of contamination could be resent and how they would have gotten there. After doing this think about what questions of concerns you may have. Do you think based on you observations lone particular contaminant may be of concern? Are you curious as to whether or not something in or around you property could be a potential source of contamination? Take the questions and concerns you have and do some quick research. From your research take what you have learned and determine what information you want to get from a soil contamination test. If one contaminant concerns you more than another include the one of higher concern and think about discarding the one of lesser concern. Be sure to consult the contaminants to test for section of this guide.

- **Look into your local resources:** The University of Alaska has a comprehensive cooperative extension service through the University of Alaska Fairbanks. There is an abundant amount of information that can be found through the cooperative extensions web site. Research for local gardening communities, and speak to famers at local farmers markets to find information and resources more proximal to your location. To get started with the UAF cooperative extension visit *www.uaf.edu/ces/*
- **Consider where your samples will be tested:** The University of Alaska Fairbanks Soil Testing Lab is a lab that serves this purpose very well. It is conveniently located in Alaska, which is beneficial in terms of time and specificity. The UAF Soil Testing Lab will also offer action recommendations based on the soil test results. However is you have taken the time to speak to those involved in gardening in your area you may find that they have used other labs of that other local labs are available. Based on what you know about the labs you know of you can consider the cost and services of the labs to determine which lab you will use. Determining a lab is an important step, as many labs will have specific sample collecting procedure they would like you to follow. This information will be needed for creating a sample strategy.
- **Create a sampling strategy:** As mentioned it the previous bullet, the testing lab you choose may provide a sample strategy to you. Other may only provide you with general sample collecting rules to follow such as how to clean you collection instruments, how deep into the soil to collect, and how to store you samples. It is highly recommended that you follow any instructions that you testing laboratory gives you. However, if you feel yourself wanting a little more guidance here as some things to consider when creating a sample design.

Considerations for creating a sampling strategy

- Consider where you want to collect your samples. Which areas of your garden are most concerned about? If you are not worried about on area over another collect several samples from different areas.
- Consider taking composite samples to find out the average contamination level of your garden. Composite samples will allow you to take more than one sample from each area and combine them to get an average testing result for that area. This would allow you to send fewer samples into the testing laboratory and possibly save on cost.
- Composite samples should be gathered from about five to ten different locations depending on the size of your garden. Each location should have 3 to 5 samples taken and mixed together to create the composite sample for each location.
- For composite samples, find a container large enough to mix the samples thoroughly, such as a large plastic bag.
- Interested in knowing the concentrations of different areas. Collect samples and keep all of the samples in separate containers.
- Make sure you keep detailed information on where each sample came from in your garden. this way if only one or two sample comeback with any concerning information you have a direct reference as to what areas of your garden are concerning.

- Collect soil from the top six inches of the soil if testing for gardening concerns.
- Collect sample from the top two inches of soil for general contamination concerns.

What contaminants to test for:

What contaminants to test for will depend largely on what you determine to be your suspected sources of contamination. Keep in mind that there are some contaminants that studies have shown to be elevated in most urban soils. Because of this even if no sources of contamination are suspected for your garden it is highly recommend that everyone include these contaminants in a soil test.

- Lead*
- Arsenic*
- Barium
- Chromium
- Cadmium
- Mercury

* These are the two most important and common contaminants to test for in any soil test.

Understanding your results:

Lab results for your samples are going to report the amount of each contaminant tested in the sample. This data can be presented in a number of formats, such as part per million (ppm), milligrams per kilogram (mg/kg), or micrograms per gram (µg/g). If results are presented in ppm it means that whatever number (parts of contaminant) that is listed is represented that many times in a million parts of soil. So let's say you have a result of 2 ppm of lead, which means there are two parts lead in every million parts of soil. Data represented in ppm are the same as data represented in mg/kg and µg/g. So what you see presented in all of these formats is a part of the contaminant per 1 million pats of soil. If you refer to the tables below

Designation	Name	Abbreviation
1	Gram	g
0.000,001	Microgram	µg

you can see how these three unit representations are all actually the same thing.

It is best to start with micrograms per gram as it translates very easily to ppm. A micro gram is 1 millionth of a gram. So numerically it looks like this 0.000,001. So if we see 2 µg/g, what is being expressed, is that there is 2 millionths of a gram of the item found in every gram of the sample? So if you had a million grams of the soil you could expect to find two grams of contaminant or 2ppm.

Designation	Name	Abbreviation
1,000	Kilogram	Kg
0.001	Milligram	mg

In the table above we see mg/kg displayed in their respective units. Kg is 1000 grams and mg is a thousandth (0.001) of a gram. What we see represented in mg/kg is a thousandth (0.001) of 1000 grams. So again we are really just looking a ppm because for every thousandth of a specific contaminant found there has to be 1000 grams of the sample. So if you had 2 thousandths (mg) of a gram of a contaminant found in one thousand (1000) grams of the sample it would you would find that there were 2 grams of the contaminant is every million grams of the sample or 2ppm.

Parts Per Billion (ppb) is another way lab results are commonly expressed. Parts per billion are a representation of parts of contaminant per billion parts solution. Think of it the same way you would ppm only the parts found is found in 1 billion parts of the sample. To convert ppb into ppm/mg/ µg/g all you need to do is to divide your ppm unit by 1000. For example:

2,000ppb/1000 = 2ppm.

Now that you understand how to convert the most commonly used measurements in soil contamination you are prepared to take your test results and compare them to contamination level recommendations. Clean up levels for soil contamination are most often based on levels found in super fund sites and do not take into consideration soil used for gardening. There are numerous sources by which gardeners can find levels recommended for remediation or levels that indicated the soil is safe for gardening use. Other resources give more specific contamination level recommendations in regards to gardening practices. Below a table of the Total Threshold Limit Concentrations of Hazardous Toxic Waste and human health screening levels (HHSL) are presented. This table is compiled from information gathered by the California Department of Toxic Substance Control and the California Office of Environmental Health Hazard Assessment respectively.

Contaminant	Below level of concern concentration in Soil (ppm)	Unsafe concentration level (ppm)
Arsenic	.07	500
Barium	5,200	10,000
Cadmium	1.7	100
Chromium	100,000	2,500
Lead	80	1,000
Mercury	18	20
	Human Health Screening Levels (HHSL)	**Total Threshold Limit Concentration for Hazardous Toxic Waste**

Notice that some contaminants such as Barium have a large discrepancy between below level of concern and unsafe concentration level while other like Mercury has a very small discrepancy. What happens if your levels fall between or are just over a level of no concern? These are questions that you as the owner and caretaker of your garden must answer. There are multiple other sources to use to compare levels too. EPA has designated Super-Fund cleanup levels specifically for Alaska. Soils Screening Levels (SSL) can be used to evaluate soils SSLs are not nation a cleanup levels but are intended help site manager's eliminate areas, pathways, and or chemicals of concern. However, SSLs are yet another tool not meant specifically for gardening.

Taking Action:

How much effort you put into understanding soil contamination and understanding how different agencies come up with their standards the better you will fell about the decisions you make concerning gardening in urban soils. Because there are no clearly defined standards for soil contamination levels it is advisable to view multiple sources to have a better understanding and larger group of comparison for your results. A great place to start researching safe/recommended levels is with the US Environmental Protection Agency.

While the USEPA has not defined soil contaminant standards they have developed values for programs dealing with soil contamination. These programs usually deal with industrial site contamination levels found in areas such as Brownsfields and are not generally relatable to urban gardening, but the values set forth do offer guidance on results as the values they present are based on risk to human health. There are Alaska specific cleanup levels that can be found by going to www.cleanuplevels.com. The Cornell Waste Management Institute is another great resource for understanding soil contamination and has a host of other helpful materials for the urban gardener. Your soil-testing lab may be another great source for some of this information as well. And of course ACAT has a large library of publications that can help in the quest of better understanding soil contaminants and health. Ask and inquire about your results with your testing lab to try and learn more about contaminants found in your garden.